2021 WETLAND HABITAT AND HYDROLOGY ANNUAL MONITORING REPORT FOR THE SAN ELIJO LAGOON RESTORATION PROJECT

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TABLE OF CONTENTS

Chapter **Page**

1. INTRODUCTION ... 1
 1.1 Project Background ... 1
 1.2 Reporting Requirements ... 2

2. TOPOGRAPHY ... 5
 2.1 Performance Standard ... 5
 2.2 Approach ... 5
 2.3 Results ... 5
 2.4 Discussion ... 6

3. BATHYMETRY ... 9
 3.1 Performance Standard ... 9
 3.2 Approach ... 9
 3.3 Results ... 9
 3.4 Discussion ... 10

4. TIDAL ELEVATIONS ... 13
 4.1 Performance Standard ... 13
 4.2 Approach ... 13
 4.3 Results ... 13
 4.4 Discussion ... 16

5. HABITAT AREAS ... 19
 5.1 Performance Standard ... 19
 5.2 Approach ... 19
 5.3 Results ... 20
 5.4 Discussion ... 25

6. VEGETATION ... 27
 6.1 Vegetative Cover ... 27
  6.1.1 Performance Standard ... 27
  6.1.2 Approach ... 30
  6.1.3 Results ... 30
  6.1.4 Discussion ... 34
 6.2 California Cordgrass (*Spartina foliosa*) Canopy Architecture ... 37
  6.2.1 Performance Standard ... 37
  6.2.2 Approach ... 37

6.2.3 Results 37
6.2.4 Discussion 39
6.3 Exotics 40
6.3.1 Performance Standard 40
6.3.2 Approach 40
6.3.3 Results 41
6.3.4 Discussion 41

7. WATER QUALITY 43
7.1 Performance Standard 43
7.2 Approach 43
7.3 Results 43
7.4 Discussion 44

8. BENTHIC INVERTEBRATES 47
8.1 Performance Standard 47
8.2 Approach 47
8.3 Results 48
8.4 Discussion 52

9. SEDIMENTS 53
9.1 Performance Standard 53
9.2 Approach 53
9.3 Results 53
9.4 Discussion 53

10. FISH 55
10.1 Performance Standard 55
10.2 Approach 55
10.3 Results 55
10.4 Discussion 60

11. BIRDS 61
11.1 Breeding Marsh Birds 61
11.1.1 Performance Standard 61
11.1.2 Approach 61
11.1.3 Results 62
11.1.4 Discussion 67
11.2 Waterbird Surveys, including Western Snowy Plover and California Least Tern 69
11.2.1 Performance Standard 69

11.2.2 Approach 69
11.2.3 Results 70
11.2.4 Discussion 76
11.3 Belding's Savannah Sparrow Surveys 77
11.3.1 Performance Standard 77
11.3.2 Approach 77
11.3.3 Results 78
11.3.4 Discussion 81

12. WETLAND FUNCTION 83
12.1 Performance Standard 83
12.2 Approach 83
12.3 Results 84
12.4 Discussion 85

13. EELGRASS 89
13.1 Performance Standard 89
13.2 Approach 89
13.3 Results 90
13.4 Discussion 91

14. CAULERPA 93
14.1 Performance Standard 93
14.2 Approach 93
14.3 Results 93
14.4 Discussion 93

15. SUMMARY OF PERFORMANCE 95
15.1 Determining year 1 Success 95

16. ADAPTIVE MANAGEMENT RECOMMENDATIONS 99
16.1 Recommendations 99
16.2 Ongoing Restoration and Maintenance activities 99

17. LIST OF PREPARERS 101

18. REFERENCES 103

LIST OF APPENDICES

Appendix A	Tidal Water Level and Velocity Monitoring 2021 Annual Report; Water Quality Analysis for San Elijo Lagoon Restoration Project Memorandum
Appendix B	Habitat Mapping 2020/2021 Memorandum
Appendix C	Plant Establishment Period Memorandum
Appendix D	Detailed Transect and Quadrat Results
Appendix E	Water Quality Data
Appendix F	2020 San Elijo Lagoon Restoration Project Post-Construction Fish and Invertebrate Assessment; 2021 San Elijo Lagoon Restoration Project Post-Construction Fish and Invertebrate Assessment
Appendix G	Sediments Characteristics Summary
Appendix H	2020 Avian Monitoring Report for the San Elijo Lagoon Restoration Project 2021 Avian Monitoring Report for the San Elijo Lagoon Restoration Project
Appendix I	San Elijo Lagoon Restoration Project Pre-Restoration and Post-Restoration Photopoints Photolog
Appendix J	San Elijo Lagoon Restoration Project California Rapid Assessment Method Analysis

LIST OF FIGURES

Figure 1-1. San Elijo Lagoon Restoration Project Timeline 2
Figure 2-1. San Elijo Lagoon Post-construction Topography/Bathymetry 7
Figure 2-2. San Elijo Lagoon Pre-construction Topography/Bathymetry.................................8
Figure 4-1. Estimated Residence Time (days) within San Elijo Lagoon 15
Figure 5-1. Design Habitat Distribution 21
Figure 5-2. Target Habitat Distribution 2020 22
Figure 5-3. Target Habitat Distribution 2021 23
Figure 6-1. Vegetation Transects Points with 2021 Habitats 31
Figure 6-2. Spartina Canopy Cover 39
Figure 7-1. 2021 Mean Hypoxic Event Duration Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands...44
Figure 8-1. 2020–2021 Benthic Invertebrate Density at San Elijo Lagoon and Reference Wetlands 49
Figure 8-2. 2020–2021 Benthic Invertebrate Species Richness at San Elijo Lagoon and Reference Wetlands 51
Figure 10-1. 2020–2021 Fish Density at San Elijo Lagoon and Reference Wetlands 57
Figure 10-2. 2020–2021 Fish Species Richness at San Elijo Lagoon and Reference Wetlands 59
Figure 11-1. LFRR Density Performance Standards Test Results 64
Figure 11-2. LRFR Abundance Performance Standards Test Results 66

LIST OF FIGURES
(Continued)

Figure 11-3. Western Snowy Plover Abundance Performance Standards Test Results............72
Figure 11-4. California Least Tern Abundance Performance Standards Test Results...............74
Figure 11-5. Belding's Savannah Sparrow Abundance Performance Standards Test Results...80
Figure 12-1. CRAM Locations and Habitats 2021...87
Figure 13-1. Mid-construction Eelgrass Survey – March 2020 90
Figure 13-2. Post-construction Eelgrass Survey – September 2021..91

LIST OF TABLES

Table 1-1. Monitoring Plan Variable Summary..4
Table 2-1. Topographic Target Habitat Distribution...6
Table 3-1. Bathymetry Target Habitat Distribution 10
Table 4-1. Target Elevation Distribution Results..14
Table 4-2. Estimated Residence Time within San Elijo Lagoon 15
Table 4-3. Average Residence Time per Basin in San Elijo Lagoon......................................16
Table 5-1. Target Habitat Distribution...19
Table 5-2. Target Habitat Distribution Results 20
Table 5-3. Target Low Marsh Acreage Results 20
Table 6-1. 10-Year Absolute Performance Standards...28
Table 6-2. Mid- and High Salt Marsh Transect Combined Planted and Unplanted Areas Monitoring Results 33
Table 6-3. Planted Mid- and High Salt Marsh Transect Monitoring Results..........................33
Table 6-4. Unplanted Mid- and High Salt Marsh Transect Monitoring Results.....................33
Table 6-5. Transitional Transect Monitoring Results 34
Table 6-6. 10-Year Absolute Performance Standards Compared to 2021 Monitoring Results...35
Table 6-7. Spartina Transect Results...38
Table 6-8. San Elijo Lagoon and Tijuana Estuary Spartina Transect Results 38
Table 6-9. Nonnative Species Detected within Marsh Transects...41
Table 7-1. Example Hypoxic Event Duration Calculation[1] 43
Table 7-2. 2021 Mean Hypoxic Event Duration Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands..44
Table 8-1. 2020–2021 Benthic Invertebrate Density Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands......................................48

LIST OF TABLES
(Continued)

Table 8-2. 2020–2021 Benthic Invertebrate Species Richness Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands....................50
Table 10-1. 2020–2021 Fish Density Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands 56
Table 10-2. 2020–2021 Fish Species Richness Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands....................58
Table 11-1. Summary of Survey Area Density Estimates for the Light-Footed Ridgway's Rail....................63
Table 11-2. Summary of Lagoon-wide Abundance Estimates for the Light-Footed Ridgway's Rail....................65
Table 11-3. Survey Detections of Other Focal Marsh Bird Species 67
Table 11-4. Summary of Western Snowy Plover Results by Month 71
Table 11-5. Summary of California Least Tern Results by Month....................73
Table 11-6. Summary of Waterbird Results by Month 75
Table 11-7. Summary of Belding's Savannah Sparrow Results by Survey Period 79
Table 12-1. CRAM Performance Standards....................83
Table 12-2. 2016 Average CRAM Attribute Scores by Wetland Type 84
Table 12-3. 2021 Average CRAM Attribute Scores by Wetland Type 85
Table 12-4. Average Attribute and Overall CRAM Scores 85
Table 13-1. Eelgrass Bed Metrics for Pre-construction Eelgrass Survey – October 2017....................89
Table 13-2. Eelgrass Bed Metrics for Post-construction Eelgrass Survey – September 2021....................91
Table 15-1. SELRP Year 1 Post-Construction Relative Performance Standards 96
Table 15-2. Timeline of SELRP Overall Project Success....................97
Table 17-1. List of Preparers....................101

ACRONYMS AND ABBREVIATIONS

AA	assessment area
AdH	Adaptive Hydraulics Modeling System
CAD	computer aided design
Cal-IPC	California Invasive Plant Council
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CDP	Coastal Development Permit
CI	confidence interval
cm	centimeter(s)
Corps	U.S. Army Corps of Engineers
CRAM	California Rapid Assessment Method
CSM	Coastal Salt Marsh
DEM	digital elevation model
I-	Interstate
LFRR	light-footed Ridgway's rail
LTMP	Long-Term Management Plan
m	meter(s)
m^2	square-meter(s)
Monitoring Plan	Wetland Habitat and Hydrology Monitoring Plan for the San Elijo Lagoon Restoration Project
NAVD88	North American Vertical Datum of 1988
OD	overdredge
PEP	plant establishment period
RTK GPS	real-time kinematic global positioning system
RWQCB	California Regional Water Quality Control Board
SELRP	San Elijo Lagoon Restoration Project
TIF	tidal inundation frequency
TN	total nitrogen
TOC	total organic carbon
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator

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1. INTRODUCTION

1.1 PROJECT BACKGROUND

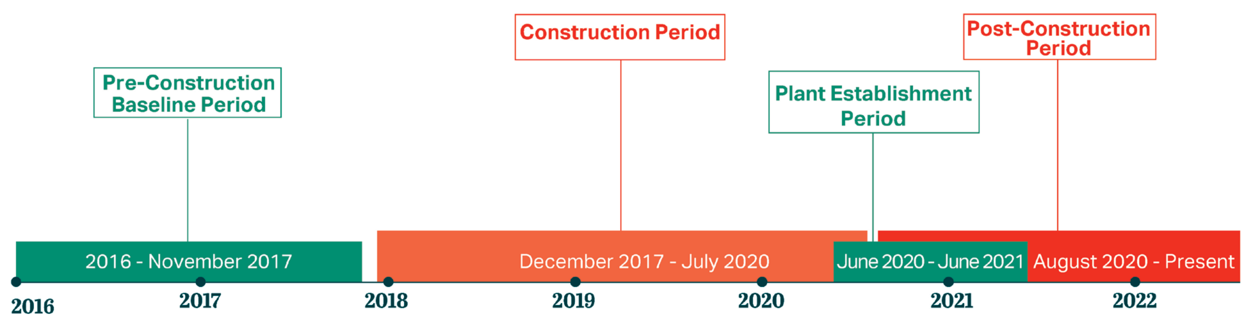
San Elijo Lagoon is a coastal wetland formed at the confluence of Escondido Creek and La Orilla Creek as they meet the Pacific Ocean. Located in the city of Encinitas, San Diego County, California, the lagoon provides habitat for sensitive, threatened, and endangered plants and animals, including resident and migratory wildlife. The San Elijo Lagoon Ecological Reserve is owned and managed by California Department of Fish and Wildlife (CDFW), County of San Diego Parks and Recreation Department, and Nature Collective (formerly San Elijo Lagoon Conservancy). Lagoon functions had become compromised over time, as development and infrastructure constraints affected the ecosystem, characterized in part by changes in the gradient of habitats within the lagoon (e.g., between unvegetated and vegetated intertidal habitats). The San Elijo Lagoon Restoration Project (SELRP) has been an effort to restore lagoon functions and services to the extent practicable given the current constraints of surrounding development.

The SELRP has been implemented by Nature Collective, San Diego Association of Governments, and California Department of Transportation District 11 to enhance and restore the physical and biological functions and services of San Elijo Lagoon. These efforts included increasing hydraulic efficiency in the lagoon, improving pre-construction water quality impairments, and halting ongoing conversion of unvegetated wetland habitats (mudflat) to vegetated salt marsh with the goal of restoring a more connected gradient of balanced habitat types. Success of the restoration effort is being measured through the implementation of a monitoring program developed in coordination with various permitting and approval agencies, including California Coastal Commission (CCC), U.S. Army Corps of Engineers (Corps), U.S. Fish and Wildlife Service (USFWS), and California Regional Water Quality Control Board (RWQCB).

Construction for the SELRP began in December 2017 and was substantively completed in July 2020 with focused activities continuing to occur in discrete areas of the lagoon. Environmentally sensitive area fence installation and vegetation clearing occurred in the central and east basins December 2017 through early March 2018 to avoid the light-footed Ridgway's rail (*Rallus obsoletus levipes*; LFRR) breeding season. Vegetation clearing in the west basin occurred in December 2018. Throughout 2018 and 2019, the overdredge (OD) pit was dredged, followed by excavation of channel side slopes and mudflat areas and channel dredging with disposal to the OD pit. Grading of transitional areas and the nest site also occurred, along with pedestrian bridge installation, construction of the inlet revetment, trail installation, and planting and irrigation. Demobilization was initiated, with final site cleanup, staging area/access/dike removal, and demobilization completed in mid-2020; some minor remedial grading also occurred within the main channel and nest site to complete the project through late 2020. Planting within restoration areas and substantive construction activities were completed in July 2020, and the 240-working day plant establishment period (PEP) was initiated in June 2020.

To assess the responses to the construction activities and changes to the habitat in San Elijo Lagoon, monitoring and data collection are grouped into three discrete periods: the "pre-construction baseline" from 2016 through 2017, a "construction period" from 2018 through July of 2020, and a "post-construction period" starting with August 2020 (Figure 1-1). For some metrics that rely more heavily on spring data (e.g., avian species), the first year post-construction may be considered 2021. For other metrics relying on data collection during the fall (e.g., fish), 2020 may be considered the start of the post-construction period. More specific information is included under the discussion for each metric. For the purposes of reporting a 4-year running average herein, construction and post-construction years have been combined into a "construction/post-construction period" which includes the years 2018 through 2021, when information is available. These data provide complementary information related to performance standards and construction/post-construction monitoring results documented as part of the monitoring program as set forth in *Wetland Habitat and Hydrology Monitoring Plan for the San Elijo Lagoon Restoration Project* (Monitoring Plan) (Nature Collective 2020).

Figure 1-1. San Elijo Lagoon Restoration Project Timeline



1.2 REPORTING REQUIREMENTS

This Annual Monitoring Report summarizes the status of the SELRP post-construction, generally 2020 (Year 0) and 2021 (Year 1). Metrics included in this Annual Monitoring Report are defined in the SELRP Monitoring Plan prepared for the project. The Monitoring Plan includes both relative and absolute metrics. Relative metrics are those that compare post-restoration conditions to reference wetlands in the region. Absolute standards require that the variable of interest be evaluated only within San Elijo Lagoon. Absolute standards are those that compare post-construction conditions to pre-construction conditions or project design. Absolute standards are not compared to reference wetlands. Absolute performance standards for the SELRP fall into two general categories:

- Project design absolute performance standards have been developed based on the SELRP design in order to meet project objectives. For example, topography or habitat cover variables have pre-determined goals based on the final design and restoration plans, or as-built conditions. These standards are not dependent on pre-restoration conditions.
- Pre-restoration absolute performance standards were developed based on the pre-restoration condition of the lagoon. These standards ensure the SELRP does not negatively impact pre-existing positive ecological attributes of San Elijo Lagoon. The standards are used to determine if post-restoration conditions are similar to pre-restoration conditions.

This Annual Monitoring Report documents conditions in the lagoon post-construction. It is framed to be consistent with the *San Elijo Lagoon Baseline Monitoring Report* (AECOM 2020a), the Monitoring Plan, and anticipated Annual Reports to facilitate reference between documents. Table 1-1 summarizes the specific resources being monitored for success of the SELRP, as well as performance standards for each of the 13 broad physical and biological variables.

Per the Monitoring Plan, annual reports will be completed as needed until Year 10 post-construction, after which a final monitoring report will be prepared and submitted. Monitoring and reporting beyond 10 years post-construction for the life of the project (defined as a minimum of 50 years) will be detailed in a Long-Term Management Plan (LTMP).

Detailed methods including data collection, monitoring frequency, analysis, and performance standards are discussed in the Monitoring Plan, which is summarized below.

Table 1-1. Monitoring Plan Variable Summary

Chapter	Variable	Variable Type	Final Performance Standard
2	Topography	Project Design Absolute	Habitat areas fall within 10% of design acreage No large-scale variations from design elevations
3	Bathymetry	Project Design Absolute	Habitat areas for subtidal habitat fall within 10% of design acreage No large-scale variations from design elevations
4	Tidal Elevation	Project Design Absolute	Habitat areas must fall within 10% of the designed habitat area targets in response to tidal inundation frequency (TIF) Predicted seawater residence time must remain on average shorter than 7 days in the central basin and 9 days in the east basin, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first order water quality
5	Habitat Areas	Project Design Absolute	Habitat areas fall within 10% from final approved habitat distribution (acreage) (CCC) including 57 to 73 acres of low marsh (USFWS)
6.1	Vegetative Cover	Project Design Absolute	Meet the 5- and 10-year absolute performance standards defined in the final restoration plan as detailed in Table 6-1 of the Monitoring Plan
6.2	California Cordgrass *(Spartina foliosa)* Canopy Architecture	Relative	Not significantly worse than the mean value (i.e., 4-year running average of the mean proportion of stems >90 centimeters at the lowest performing reference wetland
6.3	Exotics	Project Design Absolute	No more than 0% coverage by California Invasive Plant Council "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species
7	Water Quality	Relative	Not significantly worse than the mean value (i.e., 4-year running average of the mean number of consecutive hours with dissolved oxygen) at the lowest performing reference wetland
8	Benthic Invertebrates	Relative	Not significantly worse than the mean value (i.e., 4-year running average of benthic invertebrate densities and number of species) at the lowest performing reference wetland
9	Sediments	Not Applicable	No specific performance standard associated with this variable; collected to inform water quality and benthic invertebrate standards
10	Fish	Relative	Not significantly worse than the mean value (i.e., 4-year running average of fish densities and number of species) at the lowest performing reference wetland
11.1	Light-footed Ridgway's Rail	Pre-Restoration Absolute	4-year running average of density and lagoon-wide abundance of light-footed Ridgway's rail individuals are within 95% or greater of pre-construction survey data (2016, 2017)
11.2	Western Snowy Plover and California Least Tern	Pre-Restoration Absolute	4-year running average number of western snowy plover and California least tern individuals observed per survey/month are within 95% or greater of pre-construction survey data (2016, 2017)
11.3	Belding's Savannah Sparrow	Pre-Restoration Absolute	4-year running average of density of Belding's savannah sparrow individuals are within 95% or greater of pre-construction survey data (2016, 2017)
12	Wetland Function (CRAM)	Pre-Restoration Absolute	Post-restoration greater than or equal to Baseline CRAM Attribute Score
13	Eelgrass	Pre-Restoration Absolute	No permanent losses of eelgrass
14	*Caulerpa*	Pre-Restoration Absolute	*Caulerpa* absent from project site

CRAM= California Rapid Assessment Method

2. TOPOGRAPHY

2.1 PERFORMANCE STANDARD

Topography is a project design absolute monitoring variable and, as such, is not held to comparisons with reference wetlands for purposes of determining success of the SELRP. Performance standards shall be considered met if post-construction monitoring results show no large-scale variations from design elevations and habitat areas are within 10% of the design habitat distribution.

2.2 APPROACH

Per the Monitoring Plan, target elevations for low, mid-, and high salt marsh habitats, as well as wetland to upland transition zone habitat, must be met to achieve succesful restoration. The establishment and maintenance of vegetation coverage representative of these habitat types reflect that target elevations have been met. Habitat mapping within the lagoon as described in Chapter 5 is used to assess the success of this metric.

Post-construction monitoring was conducted in October 2020 to establish the post-construction topography within the site, per the Monitoring Plan Year 0 requirement. This survey established the baseline post-construction topography that will be used to identify substantial changes in the future that could affect the ability of the desired habitats to become established. Surveys were conducted using aerial imagery and were supplemented with traditional ground surveys by KDM Meridian, Coastal Frontiers Corporation, and Moffatt & Nichol. Topography in the three basins was mapped to 1-foot contours using digital aerial imagery. Elevation contours were produced in digital computer aided design (CAD) format. A complete description of survey methodology is provided in the Monitoring Plan.

Subsequent post-construction monitoring will be conducted at Years 2, 5, and 10 post-construction to assess whether the project has undergone major topographic change that could affect habitat areas. Annual monitoring for topography is not proposed as site conditions are not anticipated to change frequently enough to require annual surveys; therefore, surveys were not conducted in 2021.

2.3 RESULTS

Target habitats to confirm if the topographic performance standard is met include low, mid-, and high salt marsh habitats, as well as wetland to upland transition zone habitat, as noted in the Monitoring Plan. Table 2-1 below identifies the target acreage for those habitat categories as presented in Chapter 5 of this Annual Monitoring Report, as well as confirmation whether the 2020 and 2021 mapped acreage falls within the required range for the performance standard.

Table 2-1. Topographic Target Habitat Distribution

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped 2020	Acres Mapped 2021	Habitat Distribution Achieved (within -/+10%)
Intertidal Salt Marsh[1]	293-308	263.7/322.3 - 277.2/338.8	286.3	292.3	YES
Intertidal Mudflat[1]	32-47	28.8/35.2 - 42.3/51.7	48.3	45.8	YES
Transitional[2]	7	6.3/7.7	7.1	7.1	YES

[1] Intertidal salt marsh includes low, mid-, and high salt marsh habitats. Range is due to uncertainty of converted low marsh areas within the overdredge pit.
[2] Transitional habitat acreage has been updated to reflect refinements in geographic information system information.

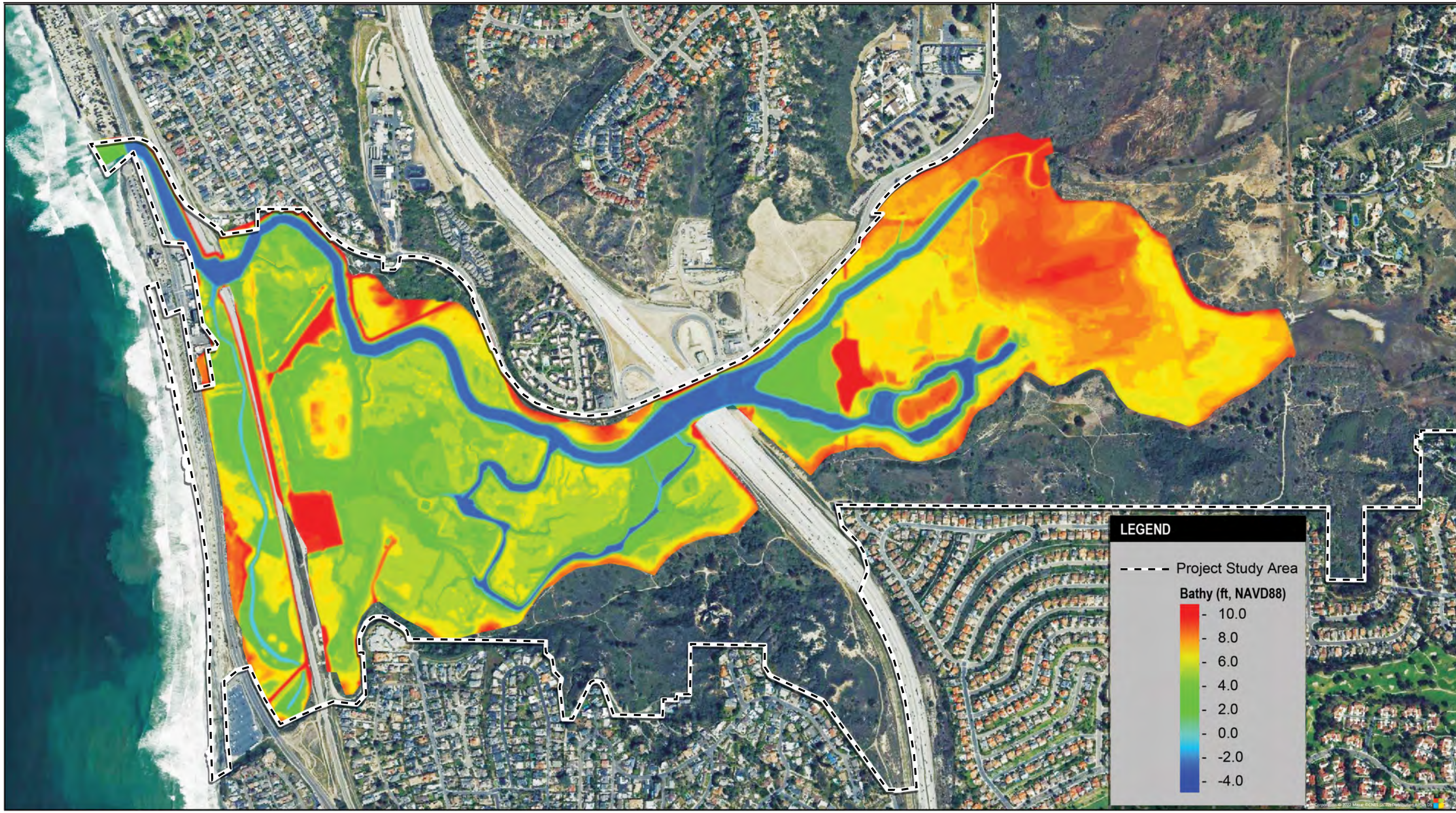
The topographic surveys conducted in 2020 document the topography of the lagoon immediately following construction (Figure 2-1), and reflects changes to topography that resulted as part of the construction process per project design.

2.4 DISCUSSION

Habitat establishment determines whether target elevations for topography have been attained. The correct elevations are critical for restoration success and drive habitat establishment. As shown in Table 2-1, habitat areas for 2020 and 2021 are within 10% of the planned habitat range for those habitat types used for the topographic performance standard. Areas for habitat types are discussed in more detail in Chapter 5, see Table 5-2and Table 5-3.

The pre-construction project site was quite variable in its topography (Figure 2-2), with the majority of the restoration site between +2 feet and +6 feet North American Vertical Datum of 1988 (NAVD88). The site was broad and low with few areas above tidal influence except along the transitional/upland borders. The post-construction project site is also variable in its topography (Figure 2-1). Similar to pre-construction conditions, the majority of the restoration site is between +2 feet and +6 feet NAVD88. Areas east of Interstate (I-)5 are higher and range from +6 feet to +10 feet NAVD88. Now that restoration is complete, Figure 2-1 will be used to identify substantial changes to topography in the future that could reduce the ability of habitat to establish. These data do not necessarily reflect focused activities that may occur after the 2020 survey as adaptive management strategies. Future reports will address subsequent activities and whether they result in changes that affect the ability of habitat to establish as designed.

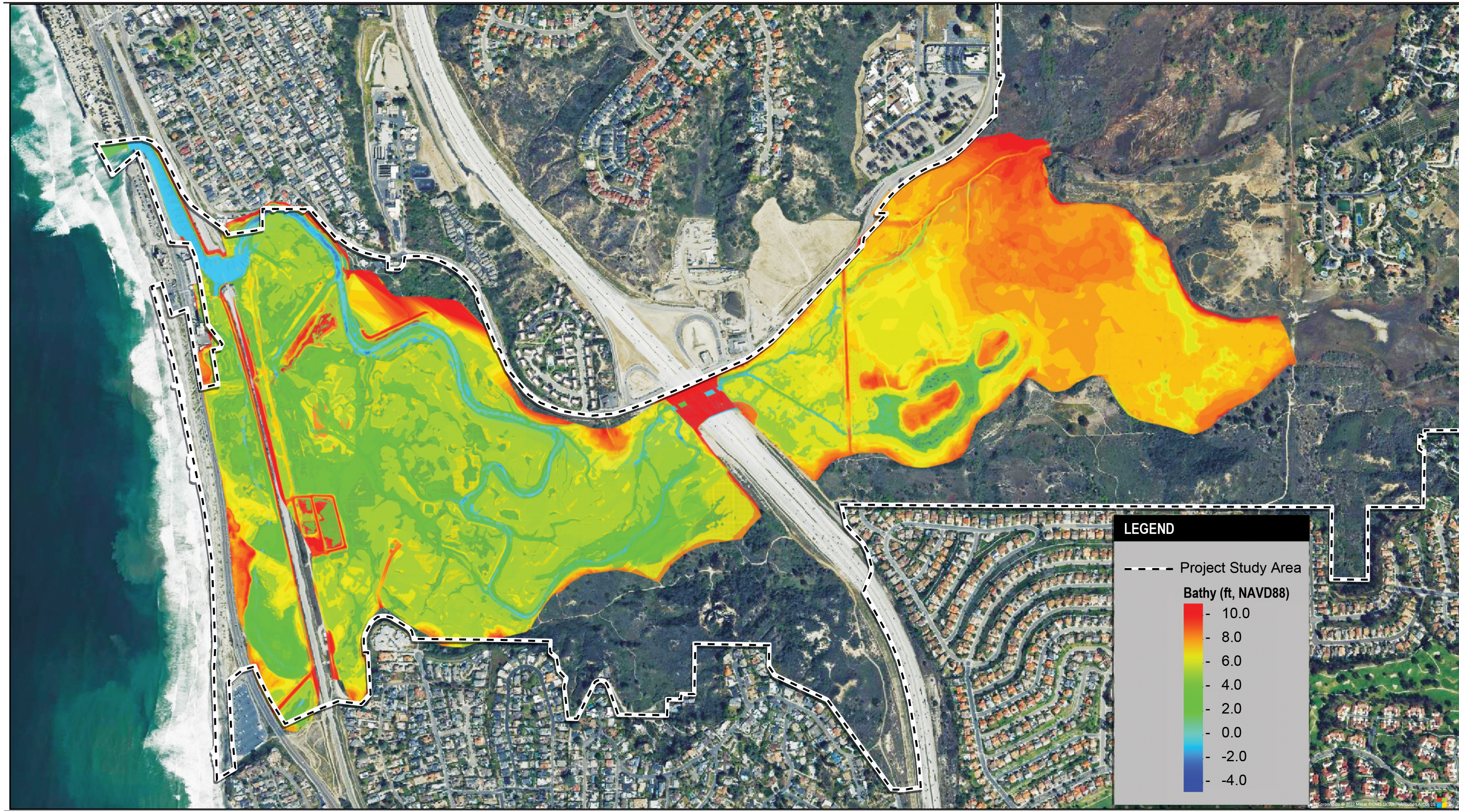
In 2020 and 2021, the topographic performance standard was met as habitat areas for the metric mapped in 2020 and 2021 fall within 10% of the design habitat acreage.



Source: Moffatt & Nichol 2022

NO SCALE

Figure 2-1
San Elijo Post-construction Topography/Bathymetry



Source: Moffatt & Nichol 2020

NO SCALE

Figure 2-2
San Elijo Lagoon Pre-construction Topography/Bathymetry

3. BATHYMETRY

3.1 PERFORMANCE STANDARD

Like topography, bathymetry is a project design absolute monitoring variable and is not subject to comparisons with reference wetlands. Performance standards shall be considered met if post-construction monitoring results show no large-scale variations from the design elevations and subtidal habitat areas are within 10% of the design acreage. Success is determined by subtidal habitat areas and their similarity to the design (i.e., within 10%).

3.2 APPROACH

Mapping of subtidal habitat area within the lagoon as described in Chapter 5 is used to assess the success of this metric.

Post-construction monitoring was completed by Coastal Frontiers in October of 2020 to establish the post-construction bathymetry within the site, per the Monitoring Plan Year 0 requirement. This survey established the baseline post-construction bathymetry that will be used to identify substantial changes in the future that could affect the ability of desired habitats to become established within the lagoon. Bathymetric data were obtained using a survey-grade digital acoustic echosounder operated from a small boat and focused on subtidal areas. Bathymetry was obtained along pre-established channel-perpendicular transects spaced at a nominal interval of 100 feet. A real-time kinematic global positioning system (RTK GPS) base-rover set was used to determine the horizontal position of each sounding, as well as the water surface elevation (relative to NAVD88). The soundings were merged with the topographic data described in Chapter 2 and used to develop a digital elevation model (DEM). A complete description of survey methodology can be found in the Monitoring Plan.

Subsequent post-construction monitoring will be conducted at Years 2, 5, and 10 post-construction to assess whether the project has undergone major bathymetric change that could affect channel capacity. Annual monitoring for bathymetry is not proposed as site conditions are not anticipated to change frequently enough to require annual surveys; therefore, surveys were not conducted in 2021.

3.3 RESULTS

Table 3-1 identifies the design acreage for subtidal habitat categories as presented in Chapter 5 of this Annual Monitoring Report, as well as confirmation whether the 2020 and 2021 mapped acreage falls within the required range for the performance standard.

Table 3-1. Bathymetry Target Habitat Distribution

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped 2020	Acres Mapped 2021	Habitat Distribution Achieved (within -/+ 10%)
Tidal Channels and Basins (Subtidal)	62	**55.8/68.2**	61.1	61.1	YES

The bathymetric survey conducted in 2020 documented the bathymetry of the lagoon immediately following construction (Figure 2-1) and reflects changes to bathymetry and channels that resulted as part of the construction process per project design. Immediately following construction, bathymetry varied throughout the site from the ocean to the east of I-5. Subtidal elevations ranged from -13 to +4.4 feet NAVD88, with tidal channel depths ranging from -2 to -4 feet NAVD88. At the time of the survey, the channel underneath the I-5 bridge was still under its construction-phase configuration, consisting of a narrow channel (about 44 feet wide) confined by sheet pile walls. The channel has now been widened per the proposed dimensions and the 2022 surveys will reflect this. Acreage does not include areas within the I-5 right-of-way; therefore, continued construction during 2020 did not affect acreage results.

3.4 DISCUSSION

Subtidal habitat area determines whether the performance standard for bathymetry has been met. The correct elevations are critical for channel capacity and lagoon function. As shown in Table 3-1, habitat areas for 2020 and 2021 are within 10% of the design acreage for subtidal habitat area used for the bathymetric performance standard. Areas for habitat types are discussed in more detail in Chapter 5, see Table 5-2 and Table 5-3.

In contrast to topography, bathymetry represents areas that are inundated 100% of the time, occur at lower elevations, and are more heavily influenced by hydraulic forces in the lagoon. Bathymetry was expected to evolve beginning immediately after construction. It is expected that sediment within tidal channels becomes mobile post-construction, and scour and deposition within the tidal channel network occur as a more stable equilibrium condition establishes. The pre-project main tidal channel was sinuous and very shallow (-2 feet NAVD88 maximum) and the proposed main channel has been deepened to -4 feet NAVD88. It has also been widened from its pre-construction condition of between 50 to 100 feet wide, to between 100 and 200 feet wide in some areas. A very long meander that existed in the main channel of the central basin remains but is improved with a new channel segment that short-cuts the meander to enhance hydraulics and improve storm flow conveyance. Now that restoration is complete, Figure 2-1 will be used to identify whether substantial future changes to bathymetry could degrade lagoon function. These data do not necessarily reflect focused activities that may occur after the 2020 survey as adaptive management strategies. Future reports will address subsequent activities and whether they result in changes that affect the ability of habitat to establish as designed.

In 2020 and 2021, the bathymetry performance standard has been met as subtidal habitat areas mapped in 2020 and 2021 fall within 10% of the design habitat acreage.

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4. TIDAL ELEVATIONS

4.1 PERFORMANCE STANDARD

Tidal elevation is a project design absolute monitoring variable and, therefore, is not compared to reference wetlands. Performance standards include the following metrics:

1. Habitat areas must fall within 10% of the designed habitat area targets in response to tidal inundation frequencies (TIFs); and
2. Predicted seawater residence time must remain on average shorter than 7 days in the central basin and 9 days in the east basin, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first order water quality.

4.2 APPROACH

Tidal elevation data were collected during 2021 to calculate both the TIF relationship with habitat areas and the estimated tidal residence time within each lagoon basin (Appendix A). Station locations are presented in the Monitoring Plan. Two tide guage locations within the main channel that were initially included were eliminated to avoid redundancy. These locations included one at the north end of the utility road and one south of Ocean Cove Drive. Tidal elevations are anticipated to vary over time depending on inlet condition, as well as sedimentation within channels. The performance standards were established to rely on longer-term variations in tidal elevations that could affect lagoon function and habitat establishment, rather than short-term variability that is a result of natural processes within an estuarine system.

Habitat was mapped in 2020 and 2021 as discussed in Chapter 5, and both topographical and tidal elevation data were used to confirm the predicted TIF of various habitat types in the lagoon.

Modeling of tidal residence time was calculated for 2021 using the Adaptive Hydraulics Modeling System (AdH) developed by the Corps Engineering Researach and Development Center (see Appendix A for details), as described in the Monitoring Plan.

4.3 RESULTS

Tidal elevation monitoring conducted in 2020 and 2021 confirmed that tide range and extent in the lagoon increased after construction and that the TIFs predicted by the project have been achieved and habitat is becoming established as designed (in specified locations and at target acreages).

As discussed further in Chapter 5, habitat areas are continuing to establish within 10% of the final design habitat distribution. The tidal elevation performance standard is considered met if target habitat areas fall within 10% of the design acreage for the project and residence times remain within the durations outlined in the Monitoring Plan within each lagoon basin.

Table 4-1 identifies the target acreage for various habitat categories as presented in Chapter 5 of this Annual Monitoring Report, as well as confirmation whether the 2020 and 2021 mapped acreage falls within the required range for the performance standard. As vegetation continues to establish in restored areas of the lagoon (e.g., OD pit), acreages may continue to shift until they reflect the TIF of the specific location.

Table 4-1. Target Elevation Distribution Results

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped 2020	Acres Mapped 2021	Habitat Distribution Achieved (within -/+ 10%)
Tidal Channels and Basins (Subtidal)	62	55.8/68.2	61.1	61.1	YES
Intertidal Mudflat[1]	32-47	28.8/35.2 - 42.3/51.7	48.3	45.8	YES
Intertidal Salt Marsh[1]	293-308	263.7/322.3 - 277.2/338.8	286.3	292.3	YES
Transitional[2]	7	6.3/7.7	7.1	7.1	YES
Total	**409**	**368.1/449.9**	**402.8**	**406.3**	**YES**

[1] Intertidal salt marsh and mudflat ranges are due to uncertainty of converted low marsh areas within the overdredge pit.

[2] Transitional habitat acreage has been updated to reflect refinements in geographic information system information.

The estimated residence time for 16 locations throughout the various basins of San Elijo Lagoon are provided in Figure 4-1 and Table 4-2.

Figure 4-1. Estimated Residence Time (days) within San Elijo Lagoon

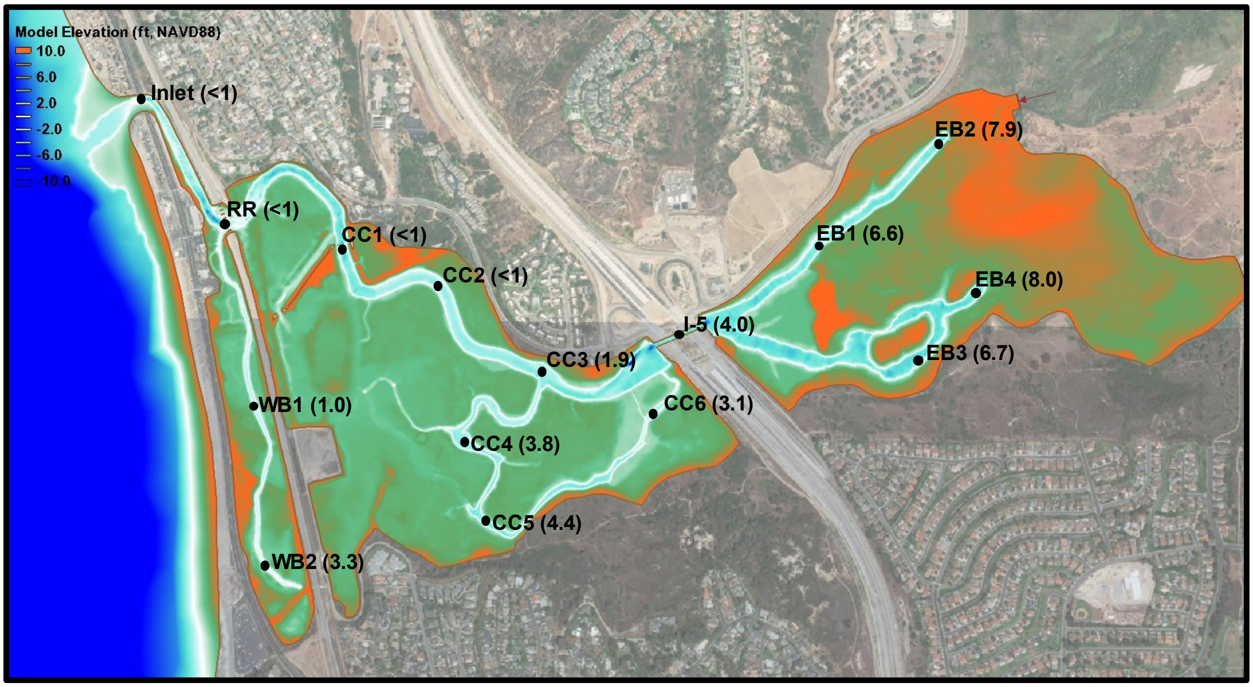

Table 4-2. Estimated Residence Time within San Elijo Lagoon

Basin	Location	Residence Time (Moving Average Days)
West Basin (WB)	Inlet	<1
	RR	<1
	WB1	1.0
	WB2	3.3
Central Basin (CC)	CC1	<1
	CC2	<1
	CC3	1.9
	CC4	3.8
	CC5	4.4
	CC6	3.1
East Basin (EB)	I-5	4.0
	EB1	6.6
	EB2	7.9
	EB3	6.7
	EB4	8.0

I- = Interstate; RR = railroad

Table 4-3 summarizes the average residence time for each basin of San Elijo Lagoon per the project performance standard. Numerical modeling analyses for seawater residence time are provided in Appendix A.

Table 4-3. Average Residence Time per Basin in San Elijo Lagoon

Basin	Average Residence Time Target	2021 Average Residence Time	Performance Standard Met
West Basin	N/A	1.3 days	N/A
Central Basin	<7 days	2.4 days	Yes
East Basin	<9 days	6.6 days	Yes

N/A = not applicable

4.4 DISCUSSION

Tides in the lagoon became broader in vertical tide range after construction. Assuming October 2020 represents the post-construction condition, then the tide range expanded throughout the entire lagoon. The high tide in the lagoon has always been the same as that in the ocean, but the low tide dropped lower than historical measurements because the downstream channel bed was lowered compared to pre-project conditions.

Tides also reach much farther upstream than prior to construction, extending into the far end of the east basin and to the southern part of the west basin, where they were previously limited to the former CDFW dike in the east and the north reach of the west basin. Tides have been slightly muted since 2020, with sand bar development near the rail bridge, but continue to have a higher range and extent than prior to construction. Tidal conditions are far superior than prior to construction and lead to tidal inundation frequency conditions conducive to proposed wetland habitat establishment.

Habitat is establishing within San Elijo Lagoon in response to the predicted TIF and consistent with project design. Residence time within the lagoon was also estimated to be less than 7 days in the central basin and less than 9 days in the east basin in 2021, consistent with the tidal elevation performance standard established for the project.

As expected, residence time in the lagoon increases with distance from the inlet, ranging from <1 day at the inlet of the lagoon, to 8 days at the far east end of the model domain. This can be explained by the hydrodynamics and the mechanisms in which transport of constituents (e.g., the water tracer) occurs at the different regions of the lagoon. Close to the inlet, tidal current velocities are the highest, and transport primarily follows the mean tidal currents: Ebb tidal currents flush out waters and flood tidal currents bring in waters from the open coast. Meanwhile tidal current velocities have drastically reduced at the far east end of the of the lagoon. In this region, diffusion, referring to the transport given by much more smaller-scale flow processes, becomes more relevant. Despite the slower velocities in the east basin, estimated residence time and habitat establishment reflect enhanced tidal flushing and consistency with the design TIF for various habitat types in 2021.

Effects of construction are no longer present in the tidal series and tidal ranges have returned to ambient post-restoration condition. In 2021, the tidal elevations performance standard has been met as habitat areas fall within 10% of the acreage proposed and average residence time remained shorter than 7 days in the central basin and 9 days in the east basin.

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5. HABITAT AREAS

5.1 PERFORMANCE STANDARD

The attainment of predicted habitats, including subtidal, intertidal mudflats, intertidal salt marsh, and transitional areas, is an absolute monitoring variable specific to two separate permit/approval requirements, is based on design target elevations, and is not compared to reference wetlands. CCC Coastal Development Permit (CDP) conditions stipulate that areas of different habitats not vary by more than 10% from the final approved design habitat distribution for the performance standard to be met. Target habitat acreages for CCC requirements are identified in Table 5-1 and shown in Figure 5-1.

Table 5-1. Target Habitat Distribution

Habitat Type	Target Acres
Tidal Channels and Basins (Subtidal)	62
Intertidal Mudflat[1]	32-47
Intertidal Salt Marsh[1]	293-308
Transitional[2]	7
Total	**409**

[1] Intertidal salt marsh and mudflat ranges are due to uncertainty of converted low marsh areas within the overdredge pit.
[2] Transitional habitat acreage has been updated to reflect refinements in geographic information system information.

A performance standard specific to low marsh target acreage has also been established pertinent only to USFWS requirements. For the performance standard to be met (USFWS), low marsh must total between 57 and 73 acres. Low marsh target acreage encompasses the lagoon as a whole because it is focused on species support, including planted areas, areas anticipated to convert over time, and existing low marsh.

5.2 APPROACH

Vegetation mapping was completed throughout the project area by AECOM during the summer of 2020 and again in the summer of 2021. Habitats were classified based on the dominant and characteristic plant species, plant physiognomy, and soils in accordance with the *Draft Vegetation Communities of San Diego County* (Oberbauer et al. 2008), as described in Appendix B. Subtidal, intertidal mudflat, and intertidal salt marsh habitats were then categorized based on the criteria identified in the San Dieguito Wetlands Restoration Project (low marsh, mid-marsh, and high marsh have been combined). Areas within the project OD pit that remain unvegetated but are anticipated to ultimately convert to vegetated marsh are identified separately and will be categorized as a specific habitat type as conversion occurs. A complete description of survey methodology can be found in the Monitoring Plan.

5.3 RESULTS

Habitat mapping in 2020 is shown in Figure 5-2. In 2021, mapping (Figure 5-3) showed a decrease of tidal mudflat and an increase of intertidal salt marsh due to the expansion of low salt marsh. The acreage of each target habitat and performance standard for each target habitat are compared in Table 5-2.

Table 5-2. Target Habitat Distribution Results

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped 2020	Acres Mapped 2021	Habitat Distribution Achieved (within -/+ 10%)
Tidal Channels and Basins (Subtidal)	62	55.8/68.2	61.1	61.1	YES
Intertidal Mudflat[1]	32-47	28.8/35.2 - 42.3/51.7	48.3	45.8	YES
Intertidal Salt Marsh[1]	293-308	263.7/322.3 - 277.2/338.8	286.3	292.3	YES
Transitional	7	6.3/7.7	7.1	7.1	YES
Total	**409**	**368.1/449.9**	**402.8**	**406.3**	**YES**

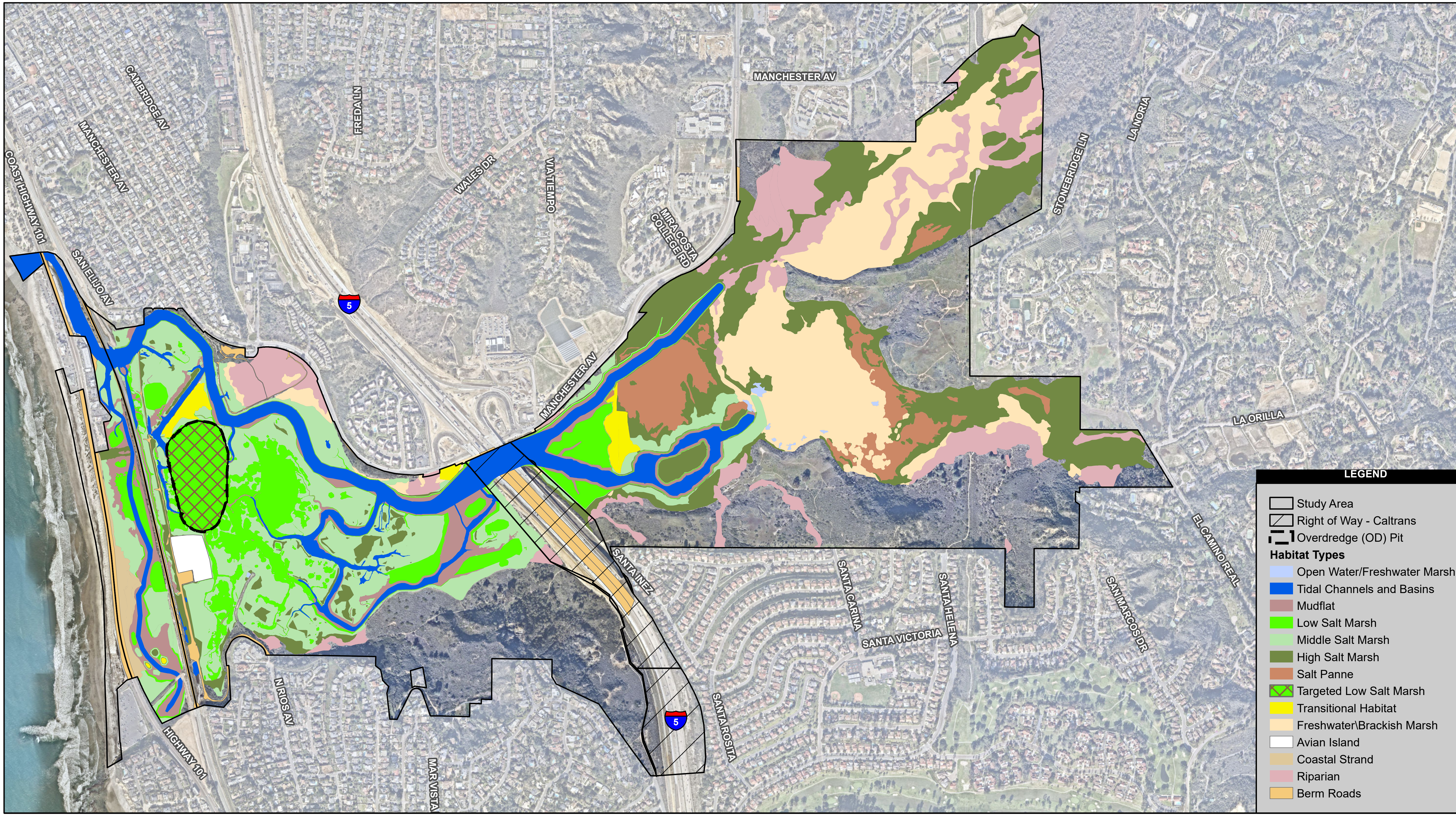
[1] Intertidal salt marsh and mudflat ranges are due to uncertainty of converted low marsh areas within the overdredge pit.

With respect to the USFWS performance standard specific to low marsh, habitat mapping conducted in 2020 resulted in a total of 55.0 acres of low salt marsh, and in 2021 a total of 61.0 acres of low salt marsh. The increase of 6.0 acres of low salt marsh was due to the expansion of cordgrass in areas that were previously mapped as mudflat and/or the unvegetated portion of the OD pit. The acreage of mapped low salt marsh and target acres for low salt marsh are compared in Table 5-3.

Table 5-3. Target Low Marsh Acreage Results

Habitat Type	Target Acres (Outside of the OD Pit)	Target Acres (Inside of the OD Pit)	Total Target Acres[1]	Target Acreage Achieved
Low Marsh (Performance Standard)	58	15	57–73	N/A
2020 Low Marsh	54.9	0.1	55.0	NO
2021 Low Marsh	57.6	3.4	61.0	YES

[1] Biological Opinion total target acreage requirements of low marsh is a range of 57–73 acres.

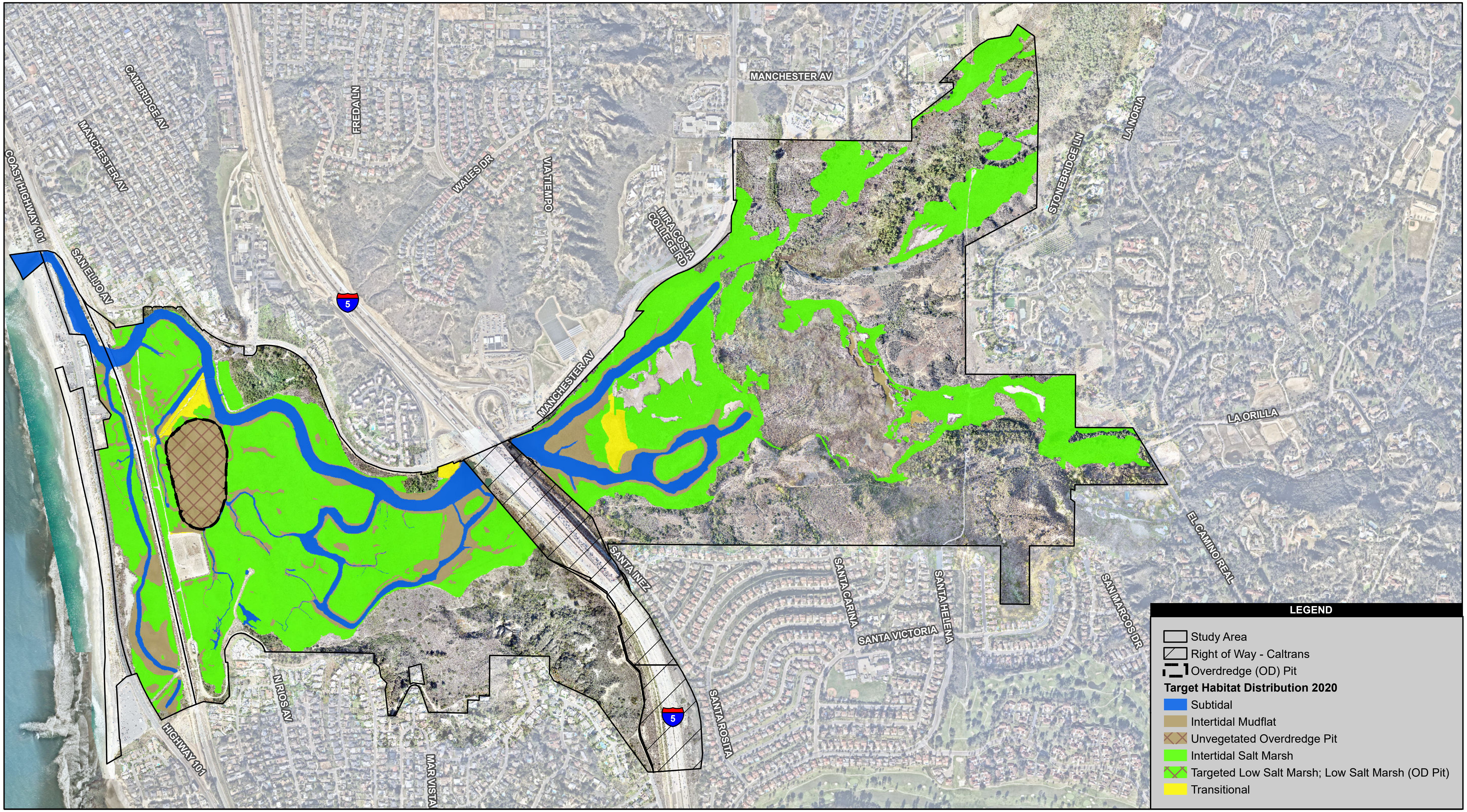


Source: SANDAG 2012; MoffattNichol 2020; AECOM.

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 5-1
Design Habitat Distribution

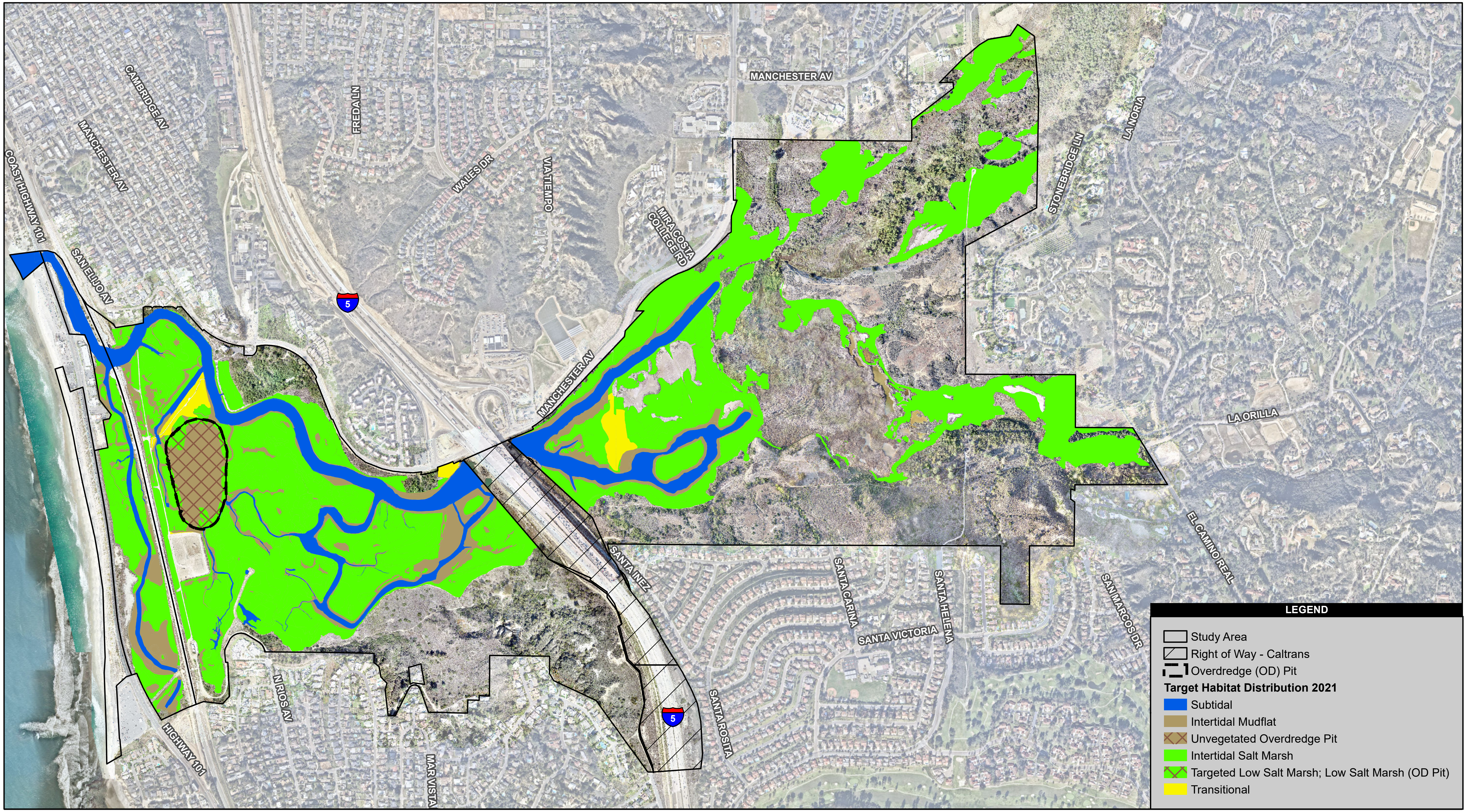


Source: SANDAG 2012; MoffattNichol 2020; AECOM.

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 5-2
Target Habitat Distribution 2020



Source: SANDAG 2012; MoffattNichol 2020; AECOM.

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 5-3
Target Habitat Distribution 2021

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5.4 DISCUSSION

Achieving habitat goals is dependent upon achieving the target goals of topography, bathymetry, and tidal elevation, which have been directly modified as part of the SELRP to ultimately alter habitat. Accordingly, habitat distribution must be within 10% of the target acreages presented in Table 5-1. Establishment and conversion of habitat are anticipated as the lagoon reaches equilibrium after the completion of restoration, and are expected to result in shifts in acreage between intertidal salt marsh, brackish marsh, and unvegetated flats. Unvegetated areas planned as vegetated salt marsh within the OD pit have not initially been mapped as habitat and will continue to be monitored until they can be characterized as a specific habitat type once they contain approximately 30% cover or can be confidently mapped as mudflat.

In 2020 and 2021, the habitat area performance standard for tidal channels and basins, mudflat, intertidal salt marsh, and transitional habitat was met as presented in Table 5-2.

In 2020, the performance standard for low marsh was not achieved. In 2021, the performance standard for low marsh was met as presented in Table 5-3.

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6. VEGETATION

6.1 VEGETATIVE COVER

6.1.1 Performance Standard

Vegetation cover is a project design absolute monitoring variable and is not subject to comparisons with reference wetlands. Performance standards for vegetation cover address the post-construction 240-workday PEP, during which the contractor was responsible for maintaining plants, as well as the performance standards necessary to meet longer-term habitat goals.

Plant Establishment Period

The 240-workday PEP performance standard required a 100% survival rate for planted species (with the exception of California cordgrass [*Spartina foliosa*]).

Vegetative Cover

The interim yearly performance standards are absolute (Table 6-1) and require the separation of low marsh from the other marsh types (mid- and high marsh). Final standards will be considered met when the Year 10 cover standards have been met.

Table 6-1. 10-Year Absolute Performance Standards

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Habitat Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
240-Workday Plant Establishment Period	N/A	N/A	N/A	N/A	N/A	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	100%
Year 1	5%	10%	N/A	10%	80% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 2	10%	20%	N/A	20%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 3	20%	30%	N/A	35%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 4	35%	45%	N/A	50%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 5	45%	55%	30%	70%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Habitat Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
Year 6	50%	60%	30%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 7	55%	65%	35%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 8	60%	70%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 9	65%	75%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 10	70%	80%	45%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)

Cal-IPC = California Invasive Plant Council; N/A = not applicable
[1] Performance standards for low marsh and mid- to high marsh will be separated by planned acreage for respective habitat types.

6.1.2 Approach

Plant Establishment Period

During the 240-workday PEP, the restoration contractor provided regular maintenance of the restoration site. In late fall 2020 and prior to the end of the 240-workday PEP, installed container plants were assessed to determine the number of container plants that had died or required replacement. A reassessment at the end of the PEP was then conducted to determine whether requirements were met and the PEP could be successfully closed.

Vegetation Cover

Vegetation cover monitoring was not conducted in 2020 due to the ongoing PEP. Quantitative vegetation cover monitoring was conducted by biologists from AECOM and Nature Collective over a 3-day period at the end of August 2021 within areas impacted during dredging and grading operations where container plants were installed, as well as areas expected to convert from a pre-construction habitat type to salt marsh. Monitoring was conducted using 30-meter (m) point-intercept transects, with a 2.5-m wide plant diversity belt on both sides of the transect line as described in the Monitoring Plan. The number of transects and placement of transects were modified slightly from the Monitoring Plan to account for access issues (i.e,, not accessible due to increase in channel width), ease of repeatablility, and the need to decrease imapcts to sensitive wildlife species. Monitoring within mid- and high salt marsh habitat included one transect in the west basin; seven transects in the central basin, and nine transects in the east basin (Figure 6-1). Monitoring within the transitional areas included three transects in the central basin and four transects in the east basin (Figure 6-1). No vegetation cover transects were placed within low marsh to monitor for cover because low marsh was monitored using transects to measure California cordgrass canopy architecture as discussed in Section 6.2. Total native and nonnative cover in each basin were determined by averaging the transect data within each basin. A complete description of survey methodology can be found in the Monitoring Plan.

6.1.3 Results

Plant Establishment Period

After planting/installation work was completed in June 2020, the 240-workday PEP began. Based on a final assessment after the 240-workday PEP, requirements of the PEP were met and the PEP was considered completed in June 2021. Detailed survey results are provided in Appendix C.

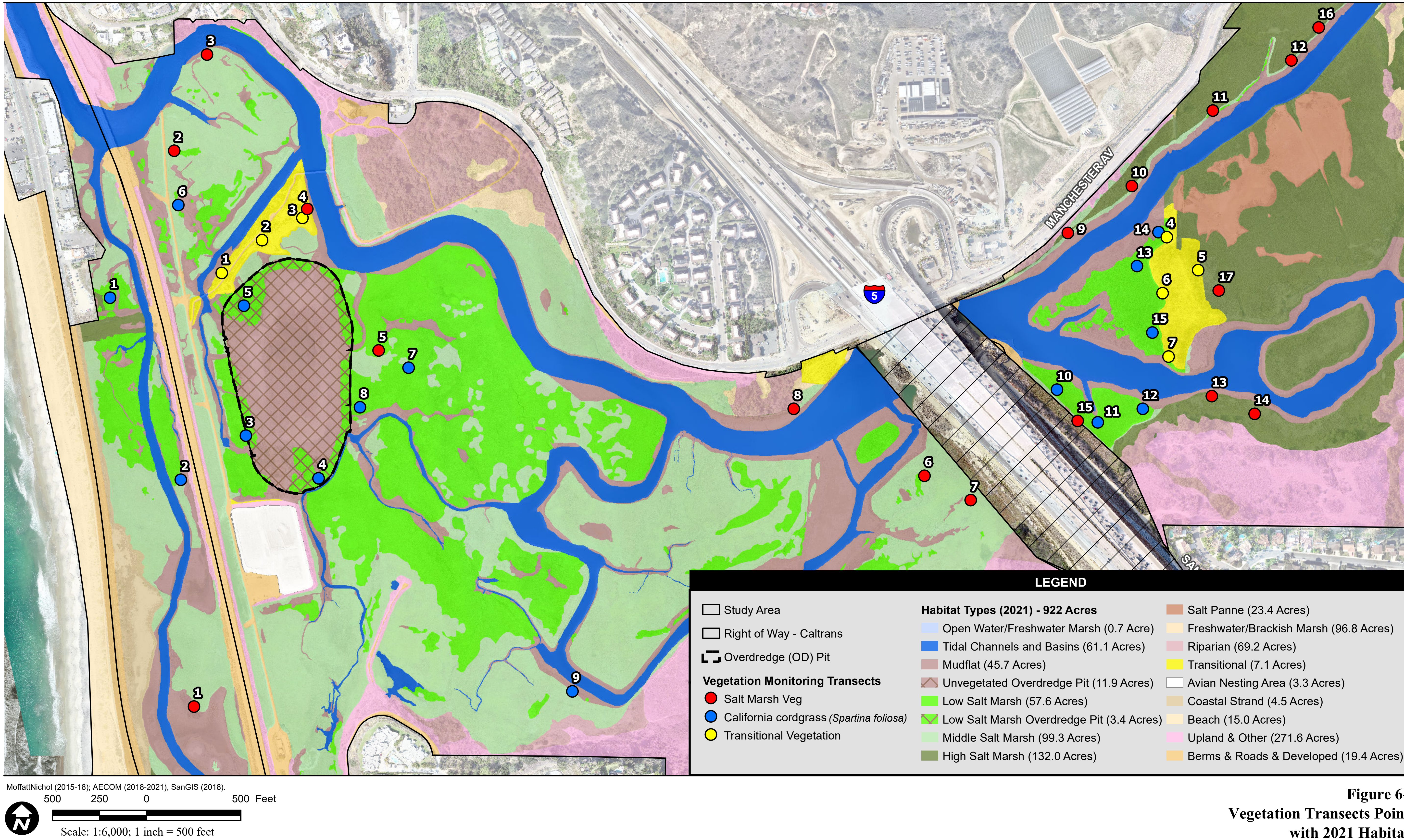

Figure 6-1
Vegetation Transects Points with 2021 Habitats

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Vegetation Cover

Transect data results from 2021 are summarized in Table 6-2 through Table 6-5. The total number of species (species richness) identified within the transects and 2.5-m wide diversity belts was 47 native species; two native species and no nonnative were recorded in the west basin, 37 native species and five nonnative species in the central basin, and 36 native species and four nonnative in the east basin. Detailed transect results by species are included in Appendix D.

Table 6-2. Mid- and High Salt Marsh Transect Combined Planted and Unplanted Areas Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
West[1]	67.2%	0.0%
Central	88.9%	0.0%
East	72.1%	3.7%
All Basins	*76.1%*	*1.0%*

[1.] Planting was not conducted in the west basin; this number reflects transect data from unplanted areas.

Table 6-3. Planted Mid- and High Salt Marsh Transect Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
West[1]	N/A	N/A
Central	76.2%	0.0%
East	80.3%	0.0%
All Basins	*78.3%*	*0.0%*

N/A = not applicable
[1] Planting was not conducted in the west basin.

Table 6-4. Unplanted Mid- and High Salt Marsh Transect Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
West	67.2%	0.0%
Central	99.0%	0.0%
East	66.0%	6.6%
All Basins	*77.4%*	*2.2%*

Table 6-5. Transitional Transect Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
Central	86.3%	0.0%
East	76.2%	0.0%
All Basins	*81.3%*	*0.0%*

6.1.4 Discussion

Plant Establishment Period

Once 100% survival rate of plants was confirmed at the end of the PEP it was closed as of June 2021, the PEP performance standard has been met.

Vegetation Cover

The vegetation cover success criteria is an absolute performance standard and success for vegetation is based on meeting the criteria identified in Table 6-1. As presented in Table 6-6, all vegetation cover performance standards have been achieved through Year 3. The performance standards for unplanted marsh native cover, planted transitional native cover, species diversity, nonnative cover, and container plant survival have been achieved through Year 10. The performance standard for planted mid- and high marsh native cover has been achieved through Year 9 with cover estimated at 78.3%. The performance standard for planted low marsh native cover has been achieved through Year 3 with cover estimated at 30%. Within low marsh areas, approximately 61 acres of the targeted 73 acres has an estimated cover of at least 30%. Low marsh cover is based on the aerial mapping for habitat assessment rather than transect data. Low marsh is also assessed using the California cordgrass canopy architecture performance standard described in Section 6.2. See Table 6-6 for specific interim performance standards.

After vegetation cover monitoring is conducted in 2022, the discontinuation or reduction of vegetation cover monitoring is being considered for a number of reasons. If the vegetation cover performance standards have been achieved, then regular transect data collection would be unnecessary, but it could be reinstated if changes occurred within the project areas (e.g., habitat distribution changes, sedimentation or erosion). When vegetation cover monitoring is conducted, there is colateral damage to the habitat, which is temporal but still present. This damage is from the direct impacts of vegetation trampling along the transects and also leads to disturbance of wildlife.

Table 6-6. 10-Year Absolute Performance Standards Compared to 2021 Monitoring Results

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
240-Workday Plant Establishment Period	N/A	N/A	N/A	N/A	N/A	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	100%
Performance Standard Status	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**Achieved**	**Achieved**
Year 1	5%	10%	N/A	10%	80% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved 30.0%**	**Achieved 78.3%**	**N/A**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 2	10%	20%	N/A	20%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved 30.0%**	**Achieved 78.3%**	**N/A**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 3	20%	30%	N/A	35%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved 30.0%**	**Achieved 78.3%**	**N/A**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 4	35%	45%	N/A	50%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Achieved 78.3%**	**N/A**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 5	45%	55%	30%	70%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Achieved 78.3%**	**Achieved 77.4%**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 6	50%	60%	30%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Achieved 78.3%**	**Achieved 77.4%**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 7	55%	65%	35%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Achieved 78.3%**	**Achieved 77.4%**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 8	60%	70%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Achieved 78.3%**	**Achieved 77.4%**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 9	65%	75%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Achieved 78.3%**	**Achieved 77.4%**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**
Year 10	70%	80%	45%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Not Achieved 30.0%**	**Not Achieved 78.3%**	**Achieved 77.4%**	**Achieved 81.3%**	**Achieved**	**Achieved**	**Achieved**

Cal-IPC = California Invasive Plant Council; N/A = not applicable

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6.2 CALIFORNIA CORDGRASS (*SPARTINA FOLIOSA*) CANOPY ARCHITECTURE

6.2.1 Performance Standard

California cordgrass (Spartina) is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The restored wetland areas shall have a Spartina canopy architecture similar to reference wetlands. The relative performance standard will be considered met if the 4-year running average of the mean proportion of stems >90 centimeters (cm) is not significantly worse than the mean value at the lowest performing reference wetland. Tijuana Estuary is the lone reference wetland used for comparison in this section as it was the only data provided because Spartina is absent in Carpenteria Salt Marsh and, until recently, uncommon in Mugu Lagoon. If Spartina begins to establish at these sites, they may be added as reference wetlands in the future.

6.2.2 Approach

Transects measuring 20 m long were established in the areas of low marsh established through construction and areas expected to convert to low marsh after construction. Transect locations are identified in Figure 6-1. Vegetation cover monitoring was not conducted in 2020 due to the ongoing PEP. Within San Elijo Lagoon, data were collected in 2021 along a total of 15 transects, including two transects in the west basin, seven transects in the central basin, and six transects in the east basin. The number and height of cordgrass stems were assessed in 0.1-square-meter (m^2) (circular) quadrats placed over the cordgrass every 2 m along each transect (a total of nine points along each transect). Maximum height (excluding flowering culms) of stems present in the quadrat was recorded and the mean proportion of stems >90 cm in height was determined for each cordgrass stand. A complete description of survey methodology can be found in the Monitoring Plan.

6.2.3 Results

Table 6-7 summarizes the results of the Spartina transects monitored within San Elijo Lagoon (Appendix D includes individual transect data). The combined density of stems in the west, central, and east basins was estimated at an average of 28.7 stems per quadrat while the proportion of stems greater than 90 cm tall per 0.1 m^2 was 0.09. At Tijuana Estuary, four transects were monitored in 2021, within which the proportion of stems greater than 90 cm tall per 0.1 m^2 was 0.14 (Table 6-8). The 1-year running average of the proportion of stems greater than 90 cm tall per 0.1 m^2 at San Elijo Lagoon was not significantly lower than the lone reference wetland (Tijuana Estuary) (Figure 6-2).

Table 6-7. Spartina Transect Results

Metric	San Elijo Lagoon	Tijuana Estuary
Density of Stems per 0.1 m^2 (Avg)	28.7	NP
Proportion of Stems >90 cm Tall per 0.1 m^2 (Avg)	0.09	0.14

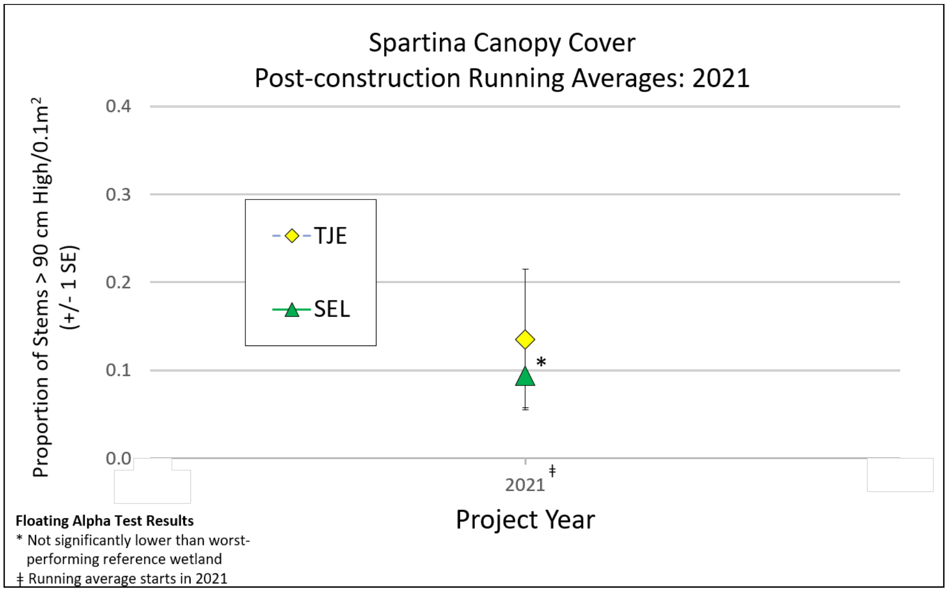
cm = centimeters; m^2 = square meter; NP = not provided

Table 6-8. San Elijo Lagoon and Tijuana Estuary Spartina Transect Results

Year(s)	Sampling Station	Spartina Canopy Cover Post-construction Running Averages: Proportion Stems >90 cm High/0.1 m^2	
		San Elijo Lagoon	Tijuana Estuary
2021	Spartina_01	0.01	N/A
	Spartina_02	0.00	N/A
	Spartina_03	0.07	0.23
	Spartina_04	0.02	0.31
	Spartina_05	0.02	0.00
	Spartina_06	0.00	0.00
	Spartina_07	0.13	N/A
	Spartina_08	0.50	N/A
	Spartina_09	0.00	N/A
	Spartina_10	0.27	N/A
	Spartina_11	0.24	N/A
	Spartina_12	0.04	N/A
	Spartina_13	0.00	N/A
	Spartina_14	0.00	N/A
	Spartina_15	0.12	N/A
	Overall Average (SE)	**0.09 (0.04)**	**0.14 (0.08)**

cm = centimeters; m^2 = square meter; N/A = not applicable; SE = Standard Error

Figure 6-2. Spartina Canopy Cover



6.2.4 Discussion

In 2021, the proportion of Spartina canopy cover at San Elijo Lagoon that was greater than 90 cm high per 0.1 m^2 was 0.09, which was not significantly lower than the 0.14 value at Tijuana Estuary. Unlike other relative standard metrics, Spartina cover is being compared to only Spartina cover values at Tijuana Estuary, which is the sole reference wetland for which Spartina data were provided. The number of transects was very different between the two sites, with four transects monitored within Tijuana Estuary and 15 transects monitored within San Elijo Lagoon. The transects with a relatively high canopy cover at San Elijo Lagoon are located within both areas that have been converting naturally over time (Transect 8) as well as transects that have been planted as part of the restoration project (Transects 10 and 11). Other transects with lower canopy cover are located in unplanted portions of the OD pit as well as areas that have been anticipated to convert over time. These transects will continue to be monitored, and canopy cover is anticipated to increase as plants establish. Transects with no cover are generally located in areas that have not historically contained Spartina and may not necessarily convert as anticipated if they remain characterized by a different type of habitat. Spartina generally requires a few years to establish, and these areas will continue to be monitored. These data represent 1 year of monitoring and therefore do not meet the criteria for the 4-year running average needed for the performance standard, but are meant to provide an early barometer of Spartina canopy cover.

After Spartina canopy monitoring is conducted in 2022, the discontinuation or reduction of monitoring Spartina canopy may be considered for a number of reasons. When Spartina monitoring is conducted, there is colateral damage to the habitat, which is temporal but still present. This damage is from the direct impacts of trampling the cordgrass along the transects and disturbance to LFRR supported within the cordgrass areas of San Elijo Lagoon. With support of LFRR as another performance standard used to evaluate success of the project, if avian monitoring indicates that LFRR are present in these areas or the LFRR performance standards are being achieved, the height of Spartina is not specifically necessary to confirm for suitability of LFRR nesting purposes. Additionally, if the required acreage of low marsh has been achieved consistent with the habitat area performance standard, then this may be sufficient to determine that LFRR have enough area to maintain populations. Finally, the number of transects monitored at San Elijo Lagoon is disproportional to the number of transects at the lone reference wetland (15 transects compared to four). While a reference wetland is useful to confirm cordgrass is consistent with general regional wetland conditions, one site is not necessarily equivalent to another. Without additional sites for comparison, site-specific conditions should also be taken into account, and the consideration of being "not significantly worse than the mean value at the lowest performing reference wetland" becomes less definitive. While some of the transects within San Elijo Lagoon are located within areas of existing cordgrass, several are in areas that may convert over time. Conversion to low marsh containing Spartina may never occur as some of these areas are surrounded by mid-marsh habitat and the species composition may be such that these areas continue to convert to habitat more dominated by species such as picklweed (*Salicornia pacifica*). Because the project is trending towards meeting the performance standard for Spartina and other metrics reflect successful support of the key target species of LFRR, it may be prudent to eliminate or reduce monitoring within the lagoon to reduce colateral impacts to LFRR and/or become more consistent with reference wetland monitoring.

6.3 EXOTICS

6.3.1 Performance Standard

Exotics are a project design absolute monitoring variable and are not subject to comparisons with reference wetlands. Conditions included in the CCC CDP and the USFWS Biological Opinion state that important functions of the restored wetland shall not be impaired by exotic species, including 0% coverage by California Invasive Plant Council (Cal-IPC) “Invasive Plant Inventory” species of “High” or “Moderate” threat and no more than 5% coverage by other exotic/weed species. Should such species exceed the thresholds, they will be removed.

6.3.2 Approach

Vegetation cover monitoring was not conducted in 2020 due to the ongoing PEP. While it is not anticipated that exotic plant species will colonize the low and mid- intertidal salt marsh areas to be restored by the SELRP, it is likely that such species could invade high salt marsh and transition areas. Surveys of vegetative cover in restored areas described in Section 6.1.2, including the 2.5-m wide diversity belt along each side of the transects for species composition, was conducted in 2021 to inform the monitoring program on the presence of exotic species. A complete description of survey methodology can be found in the Monitoring Plan.

6.3.3 Results

In the west and central basins, no nonnative plant species occurred along the marsh transects or 2.5-m wide diversity belts. In the east basin, no nonnative plant species occurred along the marsh transects or 2.5-m diversity belts within planted areas while the total estimate of nonnatives detected in transects and 2.5-m diversity belts within unplanted areas was 6.6%. When the marsh transects and 2.5-m diversity belts were averaged, the total estimate of nonnative species was 2.2%. In the central and east basins, no nonnative plant species occurred along the transitional habitat transects or 2.5-m diversity belts. The total nonnative cover recorded along transects is presented in Table 6-2 through Table 6-5. In total, eight nonnative species were identified within the marsh transects or the 2.5-m diversity belt (Table 6-9).

Table 6-7. Nonnative Species Detected within Marsh Transects

Scientific Name	Common Name	Cal-IPC Classification
Atriplex patula	fat hen	Not listed
Chenopodium album	lambs quarters	Not listed
Erigeron sumatrensis	tropical horseweed	Not listed
Euphorbia maculata	spotted spurge	Not listed
Lactuca serriola	prickly lettuce	Not listed
Melilotus albus	white sweetclover	Not listed
Melilotus indicus	annual yellow sweetclover	Not listed
Pseudognaphalium luteoalbum	Jersey cudweed	Not listed

Cal-IPC = California Invasive Plant Council

6.3.4 Discussion

Of the species identified within the transects, no “Moderate” or “High” threat species were detected. The performance standard requires 0% coverage by Cal-IPC “Invasive Plant Inventory” species of “High” or “Moderate” threat and no more than 5% coverage by other exotic/weed species. Weed species had an average cover of 2.2%, which is less than the performance standard of 5%. Therefore, the performance standard for exotics has been achieved as the cover of invasive plants with a “High” threat is 0% and the cover of other weed speces is 2.2%. Monitoring for invasive species will continue,and species with “Moderate” or “High” threat ratings will be removed as they are identified. Detailed species results are presented in Appendix D.

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7. WATER QUALITY

7.1 PERFORMANCE STANDARD

Water quality is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The final relative performance standard will be considered met if the 4-year running average of the mean number of consecutive hours with dissolved oxygen <3 parts per million is not significantly worse than the mean value at the lowest performing reference wetland.

7.2 APPROACH

Water quality data were not collected in 2020 due to ongoing construction. To calculate the relative performance metric for the SELRP, one continuous-monitoring data sonde was deployed near the inlet (Nature Center Sonde) to be analyzed for success following construction in 2021. A complete description of survey methodology can be found in the Monitoring Plan.

The criterion for event duration determines whether two readings are considered unique events or the same event. A 1-hour envelope was used to classify hypoxic events in proximity to each other as one event. The start and end of an event must be at least 1 hour apart to signal an event is complete. Otherwise, readings triggering the threshold value are considered the same event. Table 7-1 illustrates how events are categorized and event duration is calculated. No other filtering of the data was performed. The duration of each hypoxic event was quantified and then averaged across the total number of events (i.e., mean hypoxic duration). There are numerous events of only a single reading (15 minutes) that did not have any other hypoxic reading within an hour of that event occurring.

Table 7-1. Example Hypoxic Event Duration Calculation[1]

Reading	1	2	3	4	5	6	7	8	9	10	11	12	13		
Time (hr)	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3		
Examples														# Events	Duration (hr)
A	3.84	3.57	3.29	3.01	1.84	1.77	1.51	1.84	3.99	5.59	6.24	6.56	6.68	1	1
B	3.5	3.22	3.14	3.05	2.99	2.97	3.12	2.42	2.53	2.65	3.08	3.07	2.92	1	1.5
C	4.53	4.16	3.71	3.29	2.97	3.7	5.08	5.26	5.79	2.59	3.28	3.38	3.27	2	.25 (for both)

[1] Gray highlights represent hypoxic events (i.e., dissolved oxygen threshold of <3.0 milligrams per liter)

7.3 RESULTS

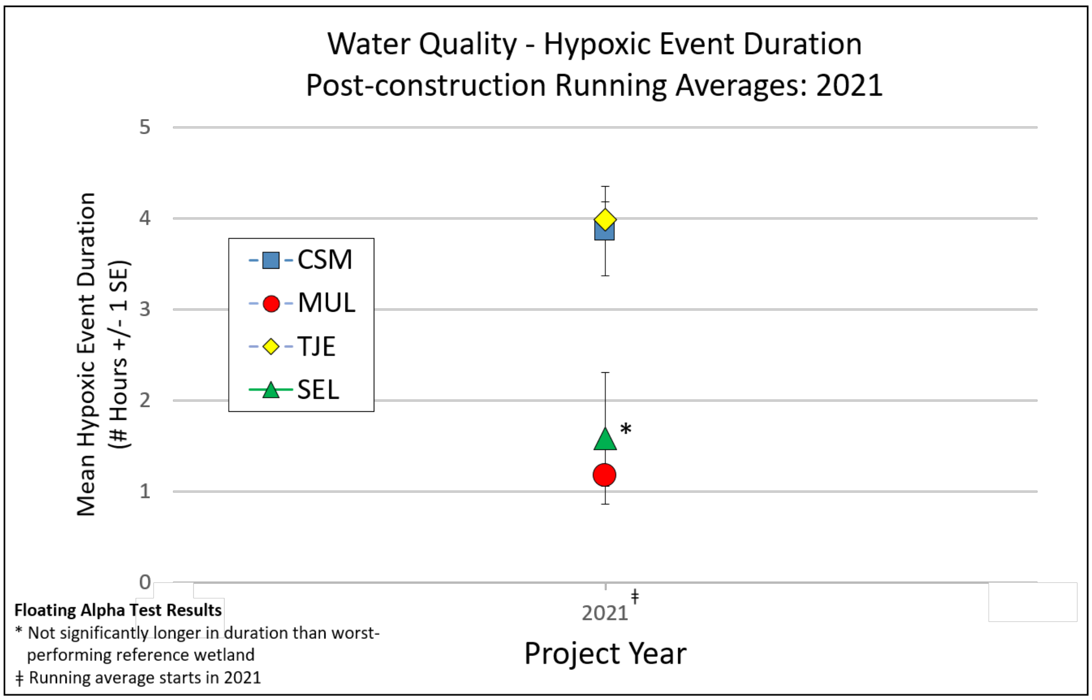
Post-construction mean hypoxic event duration at San Elijo Lagoon and the three references wetlands in 2021 is provided in Table 7-2 and Figure 7-1. These post-construction values represent a single year of data at this time, but will be the starting point for generating running averages in subsequent years. In 2021, the mean hypoxic event duration at San Elijo Lagoon was 1.58 hours (Table 7-2), which was not signficantly longer in duration that the worst performing reference wetland (Tijuana Estuary) (Figure 7-1). Appendix E details water quality data collected at the Nature Center station.

Table 7-2. 2021 Mean Hypoxic Event Duration Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Mean Hypoxic Event Duration Post-construction Running Averages: # Hours (+ - SE)			
2021	Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
	3.86 (0.49)	**1.17 (0.12)**	**3.99 (0.19)**	**1.58 (0.72)**

SE = Standard Error

Figure 7-1. 2021 Mean Hypoxic Event Duration Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands



7.4 DISCUSSION

The 2021 average hypoxic event duration at San Elijo Lagoon was 1.58 hours, which was 2.41 hours shorter than the average hypoxic event duration at Tijuana Estuary, and only 0.41 hours longer than the best performing wetland (Mugu Lagoon) (Table 7-2). This relatively low mean hypoxic event duration at San Elijo Lagoon was documented despite a single hypoxic event that lasted for 60.25 hours due to dredging activities.

These data represent the first year of water quality data post-construction and therefore cannot be used to evaluate the performance standards, but the data provide an early indicator of how restoration has impacted water quality. Improved tidal function and channel flow have reduced the mean duration of hypoxic events compared to pre-construction by more than 50%. This metric will continue to be monitored, and running averages will be generated for San Elijo Lagoon and the reference wetlands to quantitatively evaluate the performance standards.

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8. BENTHIC INVERTEBRATES

8.1 PERFORMANCE STANDARD

Benthic invertebrate community composition is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The relative performance standard will be considered met if the 4-year running average of the benthic invertebrate density and number of species at San Elijo Lagoon are not significantly worse than the mean value at the lowest performing reference wetland. Running averages are calculated for each year post-construction (2020 and 2021) to provide an early barometer of San Elijo Lagoon's performance relative to the reference wetlands.

8.2 APPROACH

During the post-construction monitoring period, benthic invertebrate populations were sampled in the fall months ranging from late September to mid-October in 2020 and 2021. Eighteen sampling stations were located in tidally influenced areas throughout the lagoon with nine stations located in main channels and nine stations located in tidal channels. Sampling station locations are presented in the Monitoring Plan, and while changes in channel topography and sedimentation may necessitate slight adjustments to the placement of the sampling stations over time, the locations remain generally consistent. Appendix F includes precise sampling locations for 2020 and 2021. Of the 18 sampling stations, historical locations that were tidally influenced prior to construction activities in 2017 (i.e., main channel sampling stations 1 through 6 and tidal channel sampling stations 1 through 6) were incorporated into the overall monitoring summary and are used for performance standard evaluations. Performance standard analysis is conducted at the wetland level and is not separated by main channel or tidal channel locations. Benthic invertebrate data from the 12 sampling stations (six each from main channel and tidal channel locations) at each reference wetland were therefore also combined to calculate wetland-level benthic invertebrate density and species richness. Locations east of I-5 (i.e., main channel and tidal channel sampling stations 7 through 9 provided in Appendix F) are considered contigency locations and are not included in the performance metric evaluations.

Benthic invertebrate sampling was conducted for both epifauna and infauna. Sampling consisted of counting individuals in quadrats and cores. Invertebrates captured during fish sampling were also counted for purposes of estimating species richness. Density was standardized to number of individuals per 100 square centimeters for each quadrat/core and then averaged across quadrats/cores at a given sampling station. Species richness was standardized to the number of unique species per sampling location (i.e., quadrats and cores combined). Additionally, unique species of macroinvertebrates captured during the seine and enclosure trapping associated with fish assemblage surveys are also included in the species richness metric; however, these species are not included in the invertebrate density metric. A complete description of survey methodology can be found in the Monitoring Plan.

8.3 RESULTS

Detailed summaries of the survey results for 2020 and 2021 are provided in Appendix F.

Benthic Invertebrate Density

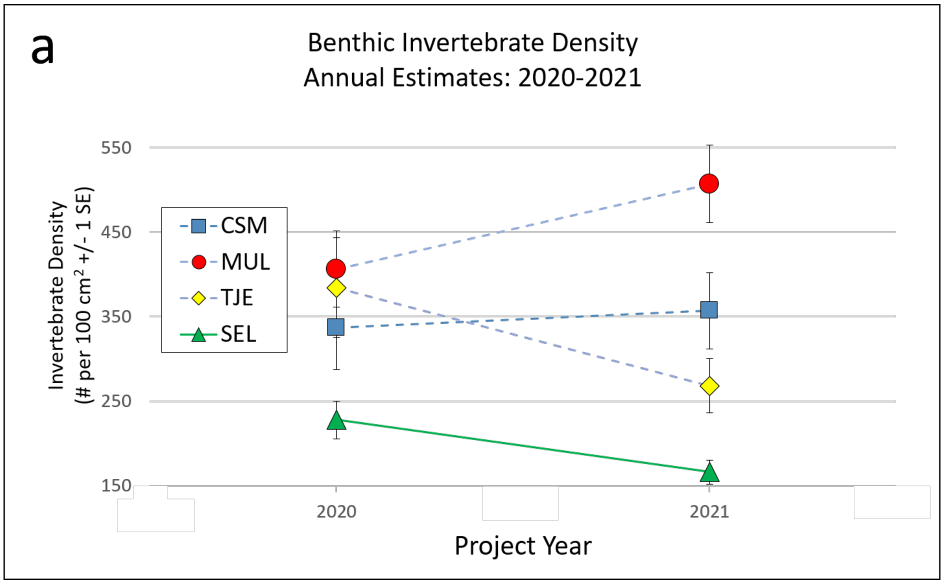
Post-construction annual estimates of benthic invertebrate density at San Elijo Lagoon and the three reference wetlands for 2020 and 2021 are provided in Figure 8-1a. Post-construction running averages of benthic invertebrate density at San Elijo Lagoon and reference wetlands for 2020 and 2021 are provided in Figure 8-1b and Table 8-1. In both 2020 and 2021, the running average of benthic invertebrate density at San Elijo Lagoon was significantly lower than the worst performing reference wetland (Figure 8-1b).

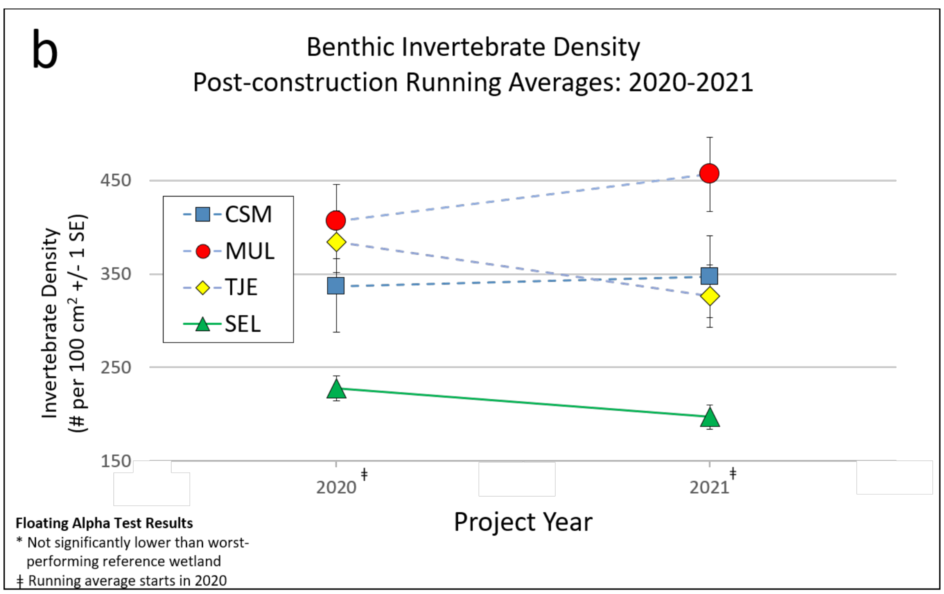
Table 8-1. 2020–2021 Benthic Invertebrate Density Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Benthic Invertebrate Density Post-construction Running Average (# Individuals/100 cm^2)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020	MC1	217.93	235.41	236.42	127.68
	MC2	276.66	513.11	309.37	273.59
	MC3	317.03	439.21	356.38	187.70
	MC4	186.25	428.46	485.42	381.14
	MC5	319.75	434.91	56.00	254.14
	MC6	252.81	283.21	480.37	157.60
	TC1	308.64	348.92	155.60	283.77
	TC2	298.70	560.53	830.33	134.81
	TC3	250.08	606.98	380.57	185.68
	TC4	465.50	626.32	432.71	297.12
	TC5	834.14	133.65	581.19	182.78
	TC6	316.06	262.21	308.38	268.21
	Overall Average (SE)	**336.96 (49.41)**	**406.08 (45.14)**	**384.4 (58.62)**	**227.85 (22.17)**
2020–2021	MC1	172.59	295.38	339.23	125.70
	MC2	272.38	509.80	403.45	223.58
	MC3	287.17	450.68	287.28	226.68
	MC4	234.50	480.15	415.12	273.93
	MC5	319.85	506.35	146.08	219.13
	MC6	374.75	507.91	340.00	176.86
	TC1	281.89	390.08	141.78	257.00
	TC2	394.31	651.89	543.99	149.09
	TC3	283.20	493.29	327.65	141.27
	TC4	391.38	656.62	283.41	201.55
	TC5	776.97	175.30	421.24	174.38
	TC6	374.22	361.33	266.33	194.20
	Overall Average (SE)	**346.93 (43.68)**	**456.56 (39.57)**	**326.30 (33.04)**	**196.94 (13.21)**

cm^2 = square centimeters; MC = main channel; TC = tidal channel; SE = Standard Error

Figure 8-1. 2020–2021 Benthic Invertebrate Density at San Elijo Lagoon and Reference Wetlands





SE = Standard Error
a. Annual estimates of benthic invertebrate density (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; TJE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.
b. Running average of benthic invertebrate density (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; TJE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

Benthic Invertebrate Species Richness

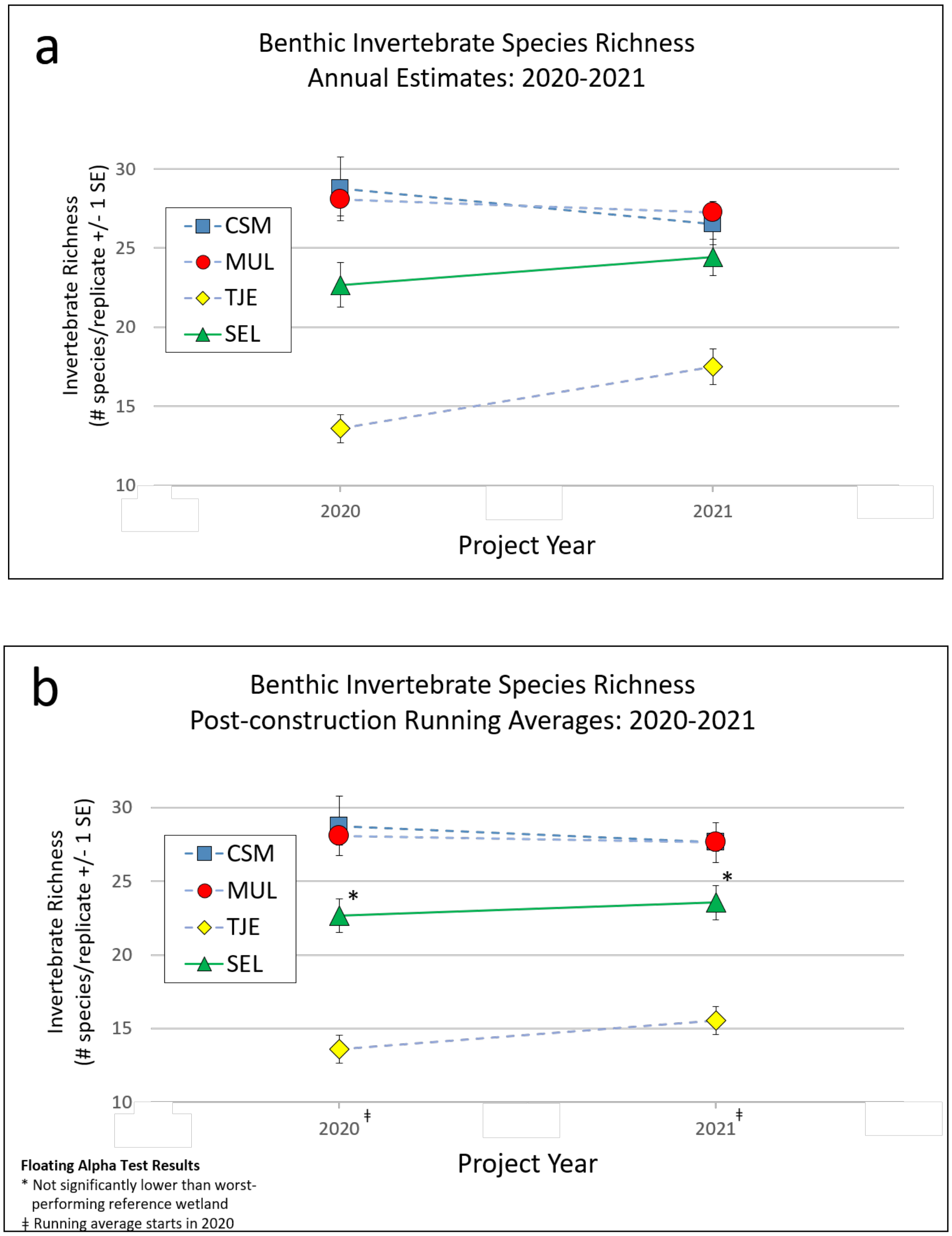
Post-construction annual estimates of benthic invertebrate species richness at San Elijo Lagoon and the three reference wetlands for 2020 and 2021 are provided in Figure 8-2a. Post-construction running averages of benthic invertebrate species richness at San Elijo Lagoon and reference wetlands for 2020 and 2021 are provided in Figure 8-2b and Table 8-2. In both 2020 and 2021, the running averages of benthic invertebrate species richness at San Elijo Lagoon were not significantly lower than the worst performing reference wetland (Figure 8-2b).

Table 8-2. 2020–2021 Benthic Invertebrate Species Richness Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Benthic Invertebrate Species Richness Post-construction Running Average (# Species/Location)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020	MC1	27.00	34.00	20.00	25.00
	MC2	40.00	24.00	13.00	25.00
	MC3	28.00	26.00	16.00	22.00
	MC4	29.00	25.00	13.00	30.00
	MC5	30.00	31.00	11.00	18.00
	MC6	27.00	33.00	14.00	22.00
	TC1	41.00	24.00	18.00	20.00
	TC2	18.00	29.00	13.00	24.00
	TC3	31.00	25.00	12.00	27.00
	TC4	30.00	29.00	12.00	13.00
	TC5	26.00	25.00	9.00	18.00
	TC6	18.00	32.00	12.00	28.00
	Overall Average (SE)	**28.75 (2.00)**	**28.08 (1.07)**	**13.58 (0.88)**	**22.67 (1.40)**
2020–2021	MC1	25.00	31.00	20.50	26.00
	MC2	34.50	24.50	17.00	26.00
	MC3	29.00	27.50	19.00	25.00
	MC4	28.50	27.50	13.00	27.50
	MC5	29.00	29.50	14.50	19.00
	MC6	30.50	29.50	16.00	24.00
	TC1	32.50	28.00	20.50	24.00
	TC2	20.50	28.00	15.50	25.00
	TC3	27.00	24.50	13.00	25.00
	TC4	30.50	27.00	12.50	15.50
	TC5	26.50	25.00	10.00	17.50
	TC6	18.00	30.00	15.00	28.00
	Overall Average (SE)	**27.63 (1.36)**	**27.67 (0.62)**	**15.54 (0.94)**	**23.54 (1.16)**

MC = main channel; TC = tidal channel; SE = Standard Error

Figure 8-2. 2020–2021 Benthic Invertebrate Species Richness at San Elijo Lagoon and Reference Wetlands



SE = Standard Error

a. Annual estimates of benthic invertebrate species richness (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; TJE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

b. Running average of benthic invertebrate species richness (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; TJE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

8.4 DISCUSSION

Benthic Invertebrate Density

The post-construction running averages of benthic invertebrate density at San Elijo Lagoon were significantly lower than benthic invertebrate density in the reference wetlands in both 2020 and 2021 (Figure 8-1b). Density of benthic invertebrates at San Elijo Lagoon and Tijuana Estuary decreased from 2020 to 2021 (Figure 8-1a), whereas benthic invertebrate density increased at Mugu Lagoon and Carpinteria Salt Marsh. The relatively low density estimates of benthic invertebrates at San Elijo Lagoon are likely a result of recent dredging activities in the lagoon as part of the restoration work. Dredging may affect benthic invertebrates more than other animal taxa because many individuals were likely removed during dredging activities, and it can take time for some of the benthic invertebrates to recolonize an area that has been dredged or impacted by sedimentation. Post-construction surveys will be conducted next in 2023 and will continue to monitor benthic invertebrate density.

Benthic Invertebrate Species Richness

The post-construction 2020 and 2021 running averages of benthic invertebrate species richness at San Elijo Lagoon exceeded that of Tijuana Estuary and were not significantly lower than the worst performing reference wetland either year (Figure 8-2b). Tijuana Estuary had by far the lowest benthic invertebrate species richness of all wetlands sampled in 2020 and 2021 (Figure 8-2a). Benthic invertebrate species richness increased slightly from 2020 to 2021 at San Elijo Lagoon and Tijuana Estuary, whereas species richness declined slightly at Carpinteria Salt Marsh and Mugu Lagoon (Figure 8-2a). Similar to benthic invertebrate density, benthic invertebrate species richness is likely negatively impacted by dredging activities, at least in the short term. As tidal flow improves and vegetation returns, the habitat at San Elijo Lagoon should become more heterogeneous and should support a greater number of benthic invertebrate species. Post-construction surveys will be conducted next in 2023 and will continue to monitor benthic invertebrate species richness.

9. SEDIMENTS

9.1 PERFORMANCE STANDARD

Sediment quality is being collected for information only and does not have a specific performance standard associated with it. In the event benthic invertebrate populations or water quality performance standards are not met, sediment quality information will be used to help identify whether there is continued presence of historic high-nutrient sediments and/or whether they continue to affect metrics with performance standards. Monitoring for grain size is also supplemental to nutrients and may be referenced for adaptive management actions if nutrient levels appear improved, but benthic invertebrate populations are not establishing as anticipated.

9.2 APPROACH

In October 2020 and November 2021, sediment samples were collected from the upper, middle, and lower tidal elevations at the same 18 sampling stations where invertebrate communities were assessed. The locations of the sampling stations are presented in the Monitoring Plan, and while changes in channel topography and sedimentation may necessitate slight adjustments to the placement of the sampling stations over time, the locations are generally consistent with the originals. Total nitrogen (TN), total organic carbon (TOC), and sediment grain size were analyzed. TN and TOC are reported as percentages by dry weight basis of the dried sediment samples. A complete description of survey methodology can be found in the Monitoring Plan.

9.3 RESULTS

The 2020 and 2021 soils reports are provided in Appendix G. In 2020, TOC ranged from 0.26% to 2.50% and, in 2021 TOC was slightly less and ranged from 0.15% to 0.87%. In 2020, TN was moderate at 0.10% on average (ranged from 0.05 % to 0.18%), while in 2021 it was slightly less moderate at 0.07% on average (ranged from 0.03% to 0.12%). In both 2020 and 2021, the soil textures ranged from very fine sand to clay, the average soil texture was silt, and sand was mostly fine to very fine.

9.4 DISCUSSION

The results above are for contextual information in interpreting the other performance standards, such as water quality and benthic invertebrates, that are part of the monitoring requirements of the restoration. The average distribution of sediment grain sizes and the composition of TOC and TN between the tidal channels and the main channels were similar.

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10. FISH

10.1 PERFORMANCE STANDARD

Fish community composition is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The relative performance standard will be considered met if the 4-year running average of fish density and number of species at San Elijo Lagoon are not significantly worse than the mean value at the lowest performing reference wetland. Running averages are calculated for each year post-construction (2020 and 2021) to provide an early barometer of San Elijo Lagoon's performance relative to the reference wetlands.

10.2 APPROACH

Fish habitat established by restoration was primarily composed of shallow subtidal channels. Intertidal channels are expected to evolve and can be added to the post-construction monitoring program upon their development. For the purposes of this monitoring program, fish monitoring in main channel/basins habitats was confined to shallow (-1.5 to -3.6 feet NGVD [National Geodetic Vertical Datum of 1929]) subtidal habitats. Fish measurements were collected in the fall of 2020 and 2021 to avoid nesting activities of the federally endangered LFRR. Fish data were collected using two methods: seining and enclosure traps. Fish sampling locations are the same as benthic invertebrate sampling locations identified in Chapter 8, and, as with the benthic invertebrates, fish data from the six main channel and six tidal channel locations were combined to calculate an overall fish density and species richness value for San Elijo Lagoon and for each of the reference wetlands. The locations of the sampling stations are presented in the Monitoring Plan and, while changes in channel topography and sedimentation may necessitate slight adjustments to the placement of the sampling stations over time, the locations are generally consistent with the originals. As discussed in Chapter 8, main channel and tidal channel locations 7 through 9 provided in Appendix F, are for reference only and are not included in the performance standard metric evaluations.

Density was standardized to number of individuals per m^2 for both seining and enclosure trap data. Species richness was standardized to number of unique species per sampling location. The averages for enclosures and seines are summed to produce a combined estimate of total density (average number per m^2) for each sampling location. A complete description of survey methodology can be found in the Monitoring Plan.

10.3 RESULTS

Detailed summaries of the survey results for 2020 and 2021 are provided in Appendix F.

Fish Density

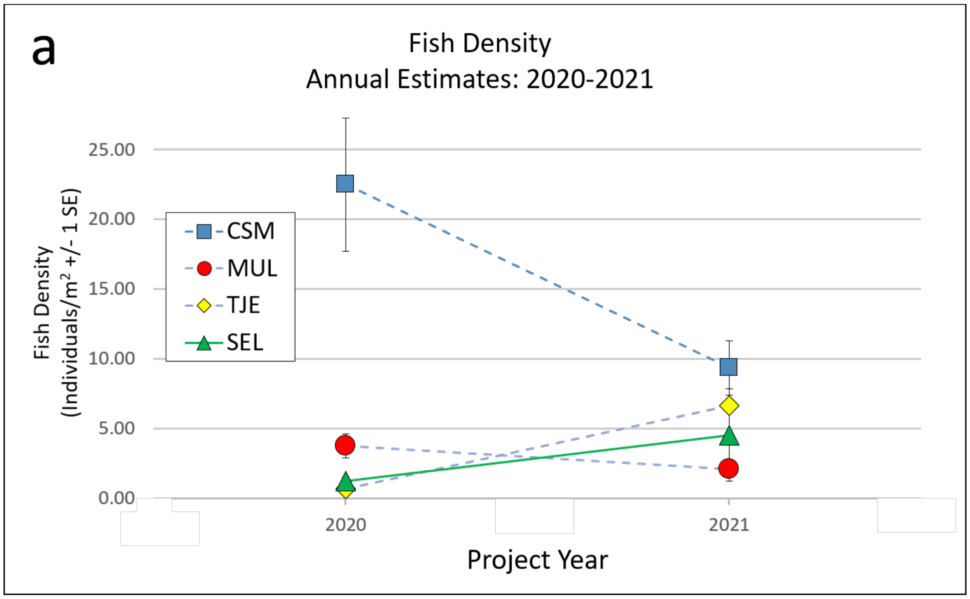
Post-construction annual estimates of fish density at San Elijo Lagoon and the three reference wetlands for 2020 and 2021 are provided in Figure 10-1a. Post-construction running averages of fish density at San Elijo Lagoon and reference wetlands for 2020 and 2021 are provided in Figure 10-1b and Table 10-1. In both 2020 and 2021, the running average of fish density at San Elijo Lagoon was not significantly lower than the worst performing reference wetland (Figure 10-1b).

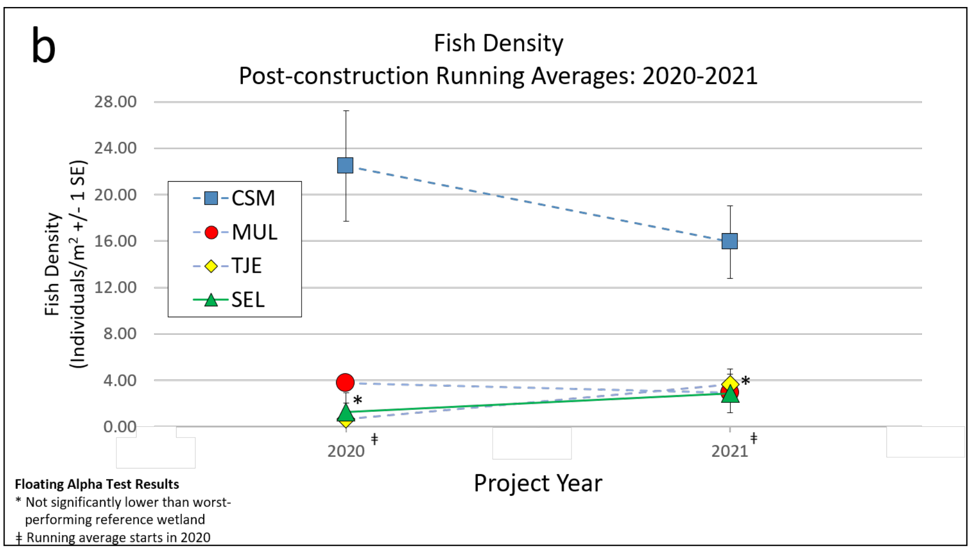
Table 10-1. 2020–2021 Fish Density Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Fish Density Post-construction Running Average (# Individuals/m^2)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020	MC1	1.04	9.36	0.19	1.51
	MC2	9.43	0.69	0.12	3.28
	MC3	27.00	2.37	0.05	1.08
	MC4	41.60	4.99	0.49	1.72
	MC5	5.33	1.99	0.55	1.21
	MC6	22.15	1.01	0.02	0.70
	TC1	3.60	5.74	2.11	0.72
	TC2	39.31	6.38	0.00	0.32
	TC3	32.42	0.85	0.47	1.19
	TC4	6.24	8.04	0.95	0.18
	TC5	43.14	2.32	2.71	0.24
	TC6	38.47	1.30	0.22	2.75
	Overall Average (SE)	**22.48 (4.76)**	**3.75 (0.87)**	**0.66 (0.25)**	**1.24 (0.28)**
2020–2021	MC1	2.65	5.22	2.47	21.08
	MC2	8.22	0.79	0.98	2.58
	MC3	15.41	2.56	10.38	0.80
	MC4	23.44	2.56	0.65	0.91
	MC5	4.31	2.26	2.61	0.85
	MC6	14.27	0.55	1.71	0.43
	TC1	3.83	3.66	15.92	1.27
	TC2	27.89	4.92	2.62	0.18
	TC3	27.82	1.29	1.11	2.12
	TC4	6.10	6.19	0.76	1.72
	TC5	29.56	2.46	3.59	0.87
	TC6	27.40	2.41	0.76	1.82
	Overall Average (SE)	**15.91 (3.11)**	**2.91 (0.51)**	**3.63 (1.36)**	**2.88 (1.67)**

m^2 = square meter; MC = main channel; TC = tidal channel; SE = Standard Error

Figure 10-1. 2020–2021 Fish Density at San Elijo Lagoon and Reference Wetlands





SE = Standard Error

a. Annual estimates of fish density (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; THE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

b. Running average of fish density (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; THE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

Fish Species Richness

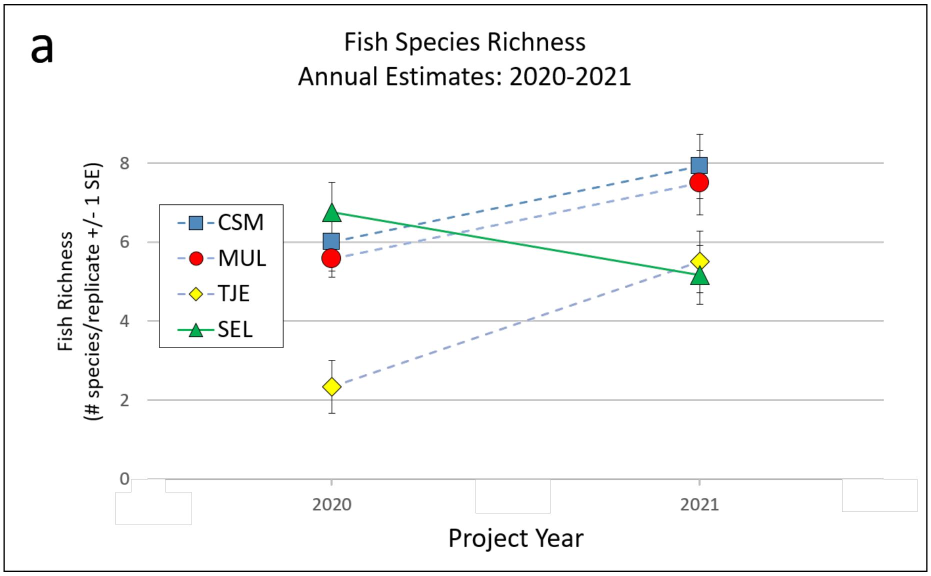
Post-construction annual estimates of fish species richness at San Elijo Lagoon and the three reference wetlands for 2020 and 2021 are provided in Figure 10-2a. Post-construction running averages of fish species richness at San Elijo Lagoon and reference wetlands for 2020 and 2021 are provided in Figure 10-2b and Table 10-2. In both 2020 and 2021, the running averages of fish species richness at San Elijo Lagoon were not significantly lower than the worst performing reference wetland (Figure 10-2b). Fish species richness annual estimates were highest at San Elijo Lagoon in 2020 and lowest in 2021 compared to the reference wetlands (Figure 10-2a).

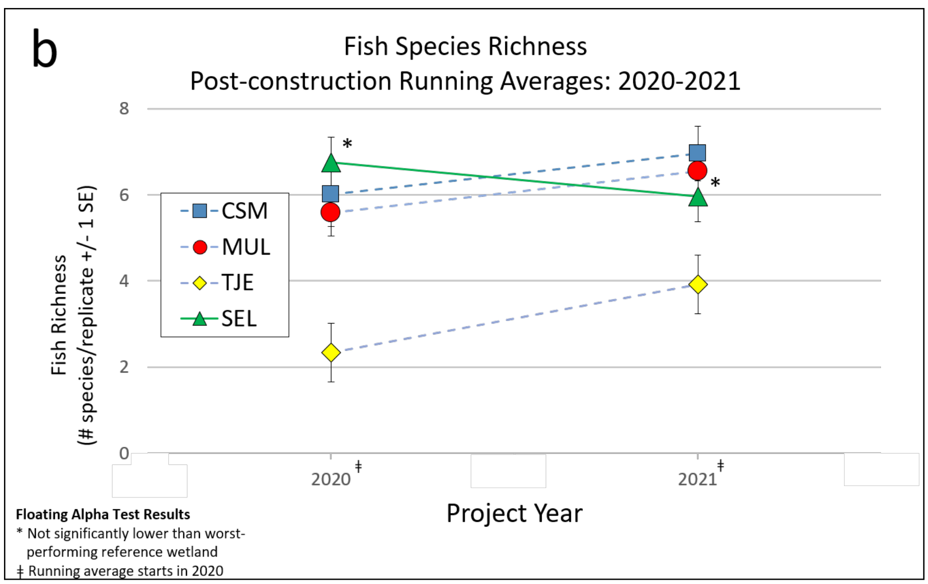
Table 10-2. 2020–2021 Fish Species Richness Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Fish Species Richness Post-construction Running Average (# Species/Location)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020	MC1	4.00	4.00	3.00	11.00
	MC2	8.00	3.00	3.00	11.00
	MC3	5.00	6.00	1.00	6.00
	MC4	10.00	5.00	2.00	8.00
	MC5	6.00	7.00	3.00	5.00
	MC6	7.00	5.00	1.00	8.00
	TC1	5.00	6.00	9.00	4.00
	TC2	4.00	4.00	0.00	7.00
	TC3	4.00	7.00	1.00	7.00
	TC4	3.00	9.00	2.00	2.00
	TC5	11.00	5.00	2.00	5.00
	TC6	5.00	6.00	1.00	7.00
	Overall Average (SE)	**6.00 (0.73)**	**5.58 (0.47)**	**2.33 (0.67)**	**6.75 (0.76)**
2020–2021	MC1	8.00	5.00	5.50	10.00
	MC2	8.50	4.50	4.50	9.50
	MC3	5.50	8.50	3.50	4.00
	MC4	7.50	4.00	3.00	5.50
	MC5	6.50	6.00	5.00	3.50
	MC6	8.00	5.00	3.00	5.50
	TC1	6.50	8.00	10.50	6.00
	TC2	6.00	6.00	3.00	5.00
	TC3	5.50	8.50	2.00	6.50
	TC4	4.00	10.00	2.50	4.50
	TC5	12.50	7.50	2.50	4.50
	TC6	5.00	5.50	2.00	7.00
	Overall Average (SE)	**6.96 (0.64)**	**6.54 (0.55)**	**3.92 (0.68)**	**5.96 (0.59)**

MC = main channel; TC = tidal channel; SE = Standard Error

Figure 10-2. 2020–2021 Fish Species Richness at San Elijo Lagoon and Reference Wetlands





SE = Standard Error

a. Annual estimates of fish species richness (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; TJE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

b. Running average of fish species richness (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM=Carpinteria Salt Marsh; MUL=Mugu Lagoon; TJE=Tijuana Estuary). See Appendix F for complete data from 2020 and 2021.

10.4 DISCUSSION

Fish Density

The post-construction running averages of fish density at San Elijo Lagoon were not signficantly lower than the worst performing reference wetland for both 2020 and 2021 (Figure 10-1b). San Elijo Lagoon and Tijuana Estuary both had relatively low fish densities in 2020 that increased slightly in 2021, whereas Carpinteria Salt Marsh and Mugu Lagoon declined from 2020 to 2021. The post-construction running averages for all wetlands were similar in 2021 with the exception of Carpinteria Salt Marsh, which had approximately four times the fish density of the three other wetlands (Figure 10-1b). As biotic and abiotic habitat settles and establishes at San Elijo Lagoon, and as food resources become established post-dredging, fish density may increase. Post-construction surveys will continue to monitor fish density moving forward.

Fish Species Richness

The post-construction running averages of fish species richness at San Elijo Lagoon were not signficantly lower than the worst performing reference wetland for both 2020 and 2021 (Figure 10-2b). Fish species richness annual estimates at San Elijo Lagoon were highest among the four wetlands in 2020, but lowest in 2021 (Figure 10-2a). Tijuana Estuary was the worst performing wetland regarding fish species richness post-construction running averages in 2020 and 2021.

Because fish are often relatively mobile, at least some species should have been able to avoid construction-related habitat disruptions and should be able to recolonize disturbed (or colonize new) habitat relatively rapidly. Species richness depends to a degree on structural complexity and availability of different habitat types, as well as different food resources. As biotic and abiotic habitat at San Elijo Lagoon settles and establishes, and as food resources become established post-dredging, fish species richness may show increases. Post-construction surveys will continue to monitor fish species richness moving forward.

11. BIRDS

11.1 BREEDING MARSH BIRDS

11.1.1 Performance Standard

The monitoring of breeding marsh birds is a “pre-restoration absolute” monitoring variable and is not compared to reference wetlands for purposes of determining success of the SELRP. Pre-construction data and construction/post-construction data metrics are compared using the “floating alpha” method described in Sections 2.1.2 and 2.2.2 of the Monitoring Plan. Performance standards for LFRR are included below.

> **Interim standard**: Construction/post-construction 4-year running average density and number of individuals 75% or greater than that of pre-construction survey data (2016, 2017) by year 7 post-construction
>
> **Final standard**: Construction/post-construction 4-year running average density and number of individuals 95% or greater than that of pre-construction survey data (2016, 2017) by year 10 post-construction

Running averages are used to account for annual population variability. Standards will not be considered met until performance standards are met for 3 consecutive years, as described in the Monitoring Plan. Data on five other “focal” marsh bird species are presented to provide additional insight into the health and condition of the lagoon but are not assessed as part of the performance standards.

11.1.2 Approach

Per the Monitoring Plan, six breeding marsh bird surveys were conducted between mid-March and mid-June each year (2018–2021). As described in the 2018–2019 Avian Monitoring Report (AECOM 2020b), survey points 9, 10, 11, and 18 were moved slightly from pre-construction points because the original locations were no longer accessible without disturbance to enhanced areas after restoration activities were completed in winter 2018–2019. Detailed information regarding the approach and the results of avian monitoring for the 2020 and 2021 years are included in Appendix H.

11.1.2.1 Light-footed Ridgway’s Rail

An independent double-observer survey approach was used for surveys, meaning two ornithologists were present for each survey (Nichols et al. 2000) and each ornithologist recorded data independently of the other ornithologist. Detection probabilities were estimated from each of the six surveys to derive LFRR estimates and abundance values. LFRR abundance and the associated 95% upper and lower confidence limits (UCL and LCL, respectively) were calculated separately for each of the six surveys using a closed mark-recapture model (Huggins 1991). Model-averaging was used to generate LFRR estimates and confidence intervals (CIs) for 2016 through 2021 in this Annual Monitoring Report.

Survey Area Density Estimates

Annual LFRR survey area density estimates were calculated by dividing the model-generated estimate of LFRR abundance within the survey area by the total acreage of “preferred” habitat within the survey area for each year, as described in Appendix H.

Lagoon-wide Abundance Estimates

To estimate the LFRR population size for the entire lagoon (i.e., lagoon-wide abundance estimate), including both surveyed and unsurveyed areas, LFRR density estimates and associated CIs were multiplied by the total acreage of preferred habitat across the entire lagoon, as described in Appendix H.

11.1.2.2 Other Focal Marsh Bird Species

Results for five other species of marsh birds are provided as the average number of individuals detected per survey. There was an insufficient number of detections for these other species to generate modeled estimates of abundance. For this reason, raw numbers of detected individuals are presented as an index reflecting relative abundance.

11.1.3 Results

Detailed summaries of the survey dates, survey times, survey personnel, and weather conditions for 2020 and 2021 are provided in Appendix H.

11.1.3.1 Light-footed Ridgway’s rail

Survey Area Density Estimates

LFRR were detected predominantly in areas dominated by Coastal Brackish Marsh, Coastal Salt Marsh (CSM) – Low, and CSM – Mid. Locations of LFRR detections from 2020 and 2021 surveys are depicted in Appendix H. Based on results from the Huggins (1991) model, LFRR survey area density estimates for each of the six surveys conducted in 2018–2021 are presented in Table 11-1 with associated model-generated 95% CIs. Values represent the estimated number of individuals per acre of preferred habitat within the survey area. Average pre-construction baseline period LFRR density estimates are also presented for the surveys conducted in 2016–2017, as well as the 4-year construction/post-construction average. The 4-year construction/post-construction average from 2018–2021 was 0.21 individuals/acre, which was the same as the pre-construction baseline average (Table 11-1; Figure 11-1a and Figure 11-1b). Results from the floating alpha testing method indicated the 4-year construction/post-construction average was not significantly lower than 75% of the pre-construction baseline mean, nor was it significantly lower than 95% of the pre-construction baseline mean. Thus, both the interim and final performance standards were met for LFRR density (Figure 11-1b).

Table 11-1. Summary of Survey Area Density Estimates for the Light-Footed Ridgway's Rail

Survey Number	LFRR Survey Area Density Estimates; # Individuals/Acre					
	2016–2017 Baseline Estimate[1]	2018 Estimate (95% CI)[2]	2019 Estimate (95% CI)[2]	2020 Estimate (95% CI)[2]	2021 Estimate (95% CI)[2]	4-year Construction/ Post-construction Running Average[3]
1	0.25	0.35 (0.32-0.37)	0.11 (0.10-0.12)	0.33 (0.31-0.35)	0.28 (0.27-0.29)	0.27
2	0.22	0.32 (0.30-0.33)	0.19 (0.18-0.2)	0.22 (0.22-0.22)	0.29 (0.27-0.3)	0.25
3	0.23	0.29 (0.28-0.29)	0.19 (0.18-0.19)	0.22 (0.21-0.23)	0.25 (0.25-0.26)	0.24
4	0.21	0.27 (0.26-0.27)	0.14 (0.14-0.15)	0.12 (0.11-0.12)	0.17 (0.16-0.18)	0.18
5	0.17	0.22 (0.21-0.23)	0.09 (0.08-0.10)	0.12 (0.12-0.12)	0.23 (0.23-0.24)	0.16
6	0.18	0.15 (0.15-0.16)	0.07 (0.06-0.07)	0.25 (0.24-0.26)	0.27 (0.26-0.28)	0.19
Overall Mean (95% CI)[4]	**0.21 (0.18 – 0.23)**	**0.27 (0.21-0.32)**	**0.13 (0.09-0.17)**	**0.21 (0.14-0.28)**	**0.25 (0.22-0.28)**	**0.21 (0.18 – 0.25)**

CI = confidence interval

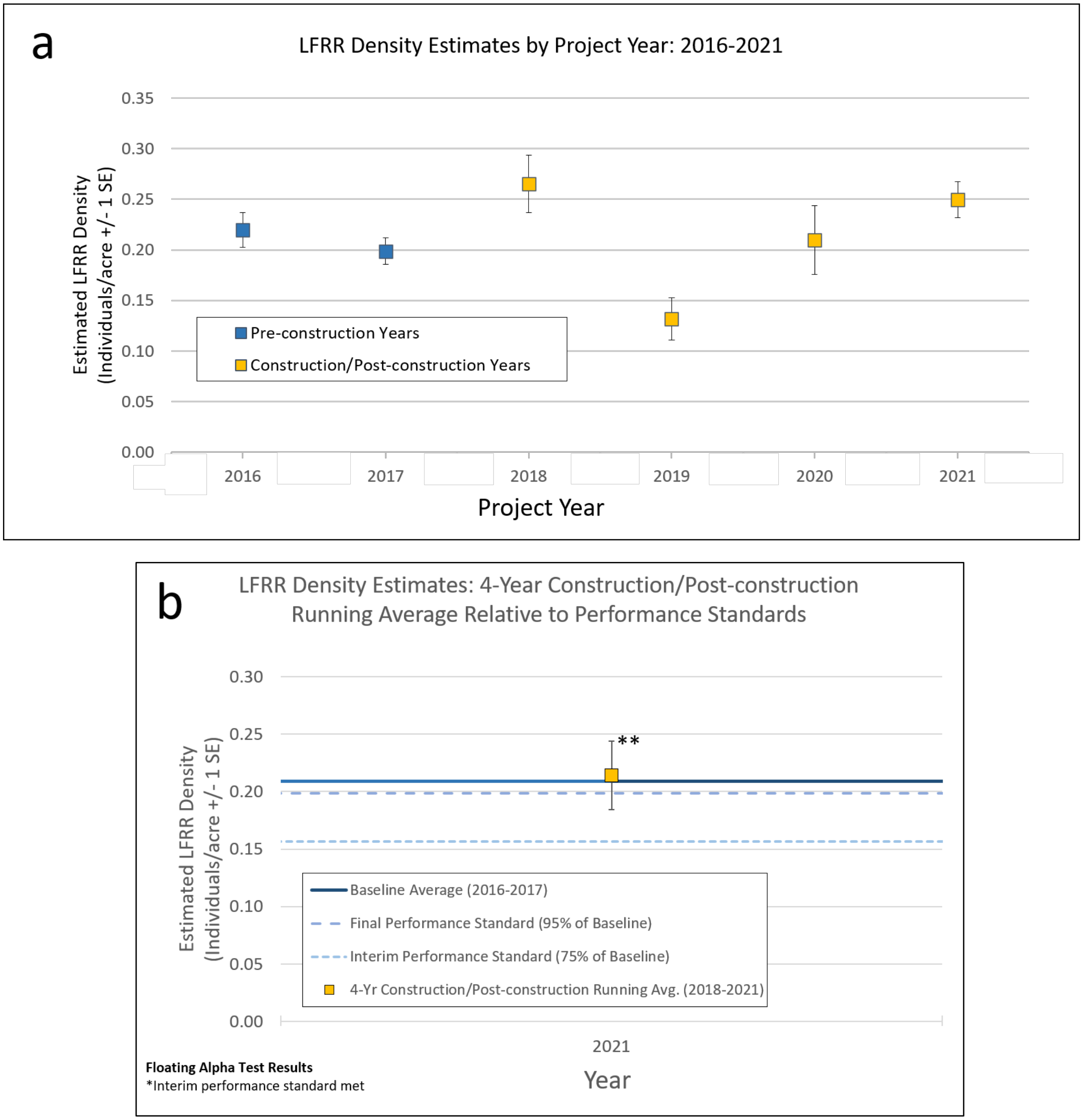
[1] 2016 and 2017 pre-construction baseline averages from SELRP Baseline Monitoring Report (AECOM 2020a).

[2] Density estimates and 95% CIs for Surveys 1 through 6 were calculated by dividing the model-generated LFRR abundance estimates (and associated confidence limits) within the survey area by the amount of preferred habitat within the survey area (see Section 11.1.2.1 for acreage for each year).

[3] The six survey-specific density estimates in these columns were calculated as the mean of 2018 through 2021 density estimates and lack model-generated confidence limits.

[4] Overall Mean Estimates in this row were calculated as the mean of the six survey-specific estimates. Confidence limits for 95% CIs calculated as mean estimate +/- 1.96 x standard error of the six estimates.

Figure 11-1. LFRR Density Performance Standards Test Results



Lagoon-wide Abundance Estimates

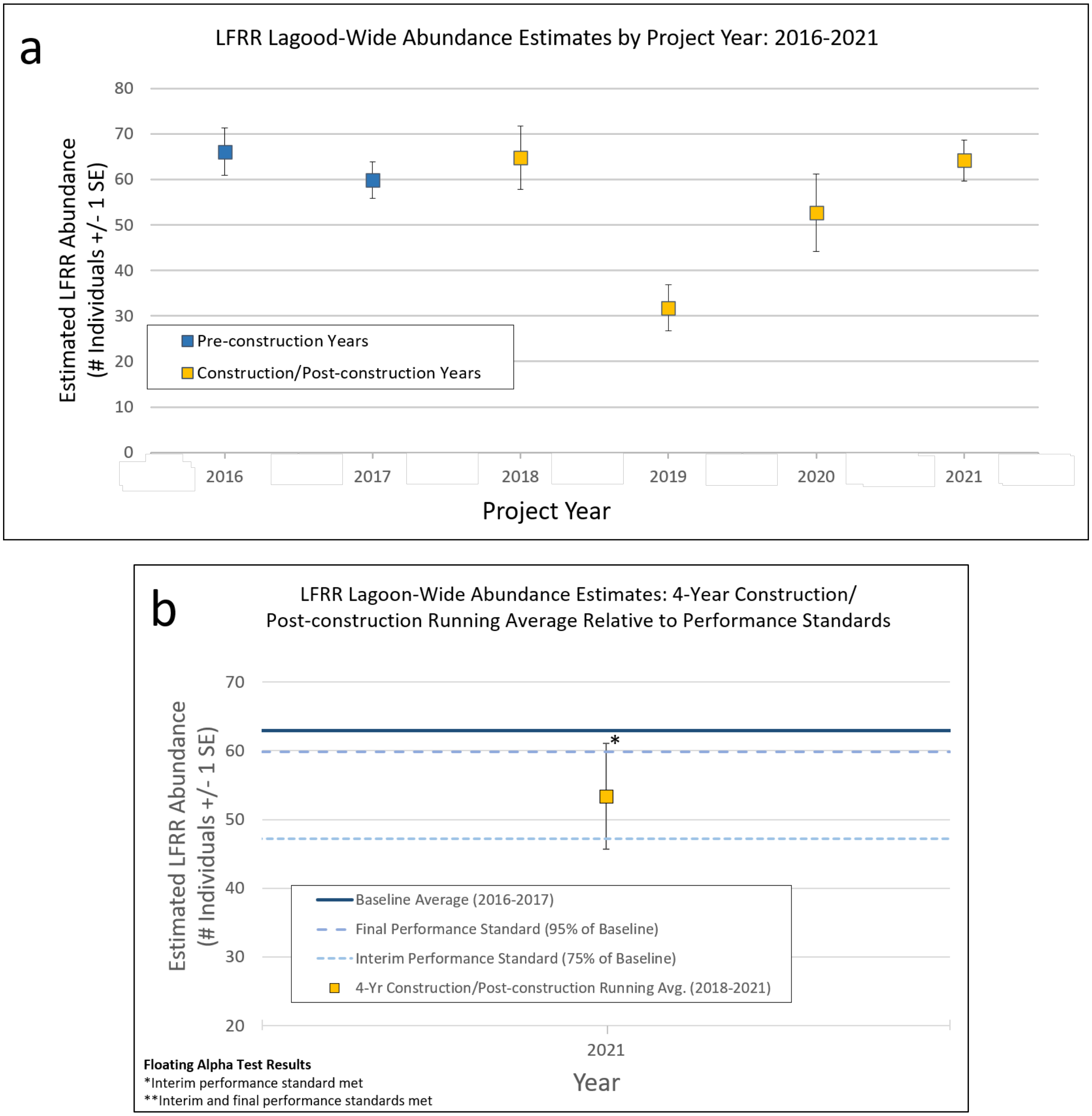
The lagoon-wide LFRR abundance estimates were 52.66 individuals and 64.19 individuals in 2020 and 2021, respectively (Table 11-2). The 4-year construction/post-contruction mean lagoon-wide abundance estimate of 53.34 individuals was lower than the pre-construction baseline mean lagoon-wide abundance estimate of 62.98 individuals (Table 11-2; Figure 11-2a & Figure 11-2b). Results from the floating alpha testing method indicated the 4-year average lagoon-wide average was not significantly lower than 75% of the pre-construction baseline mean, but was signficantly lower than 95% of the pre-construction baseline mean (Figure 11-2b). This indicates that while the interim performance standard was met for this metric, the final performance standard was not.

Table 11-2. Summary of Lagoon-wide Abundance Estimates for the Light-Footed Ridgway's Rail

Survey Number	LFRR Lagoon-wide Abundance Estimates					
	2016–2017 Baseline Estimate[1]	2018 Estimate (95% CI)[2]	2019 Estimate (95% CI)[2]	2020 Estimate (95% CI)[2]	2021 Estimate (95% CI)[2]	4-year Construction/Post-construction Running Average[3]
1	75.06	84.82 (79.26-90.38)	26.52 (24.98-28.07)	83.24 (78.87-87.62)	71.79 (69.44-74.15)	66.60
2	66.38	77.04 (72.93-81.15)	46.42 (44.33-48.51)	55.28 (54.32-56.25)	73.97 (70.28-77.66)	63.18
3	68.79	70.55 (69.18-71.92)	44.77 (42.71-46.82)	55.87 (53.48-58.27)	65.25 (63.04-67.47)	59.11
4	63.13	65.49 (64.59-66.39)	34.82 (33.02-36.61)	29.31 (28.44-30.18)	44.02 (42.28-45.76)	43.41
5	49.91	52.96 (50.68-55.25)	21.55 (20.17-22.93)	29.21 (28.92-29.50)	60.14 (58.41-61.88)	40.97
6	54.60	37.65 (37.04-38.25)	16.58 (15.36-17.79)	63.05 (59.56-66.54)	69.94 (68.00-71.89)	46.80
Overall Mean (95% CI)[4]	**62.98 (55.54 – 70.42)**	**64.75 (51.07-78.43)**	**31.77 (21.94-41.61)**	**52.66 (36.05-69.28)**	**64.19 (55.34-73.03)**	**53.34 (44.58-62.11)**

CI = confidence interval
[1] 2016 and 2017 pre-construction baseline averages from SELRP Baseline Monitoring Report (AECOM 2020a).
[2] Lagoon-wide abundance estimates and 95% CIs for Surveys 1 through 6 were calculated by multiplying the model-generated LFRR density estimates for each year/survey (and associated confidence limits) by the amount of suitable preferred habitat across the lagoon that year (see Section 11.1.2.1 for acreage for each year).
[3] The six survey-specific density estimates in these columns were calculated as the mean of 2018 through 2021 density estimates and lack model-generated confidence limits.
[4] Overall Mean Estimates in this row were calculated as the mean of the six survey-specific estimates. Confidence limits for 95% CIs calculated as mean estimate +/- 1.96 x standard error of the six estimates.

Figure 11-2. LRFR Abundance Performance Standards Test Results



11.1.3.2 Other Focal Marsh Bird Species

As stated above, the focal marsh bird data represent the number of detections within the survey area and are not adjusted for the amount of suitable habitat or extrapolated to provide an estimate of the lagoon-wide abundance. Detections of focal marsh bird species recorded during survey efforts are included in Table 11-3. On average, Virginia rails were the most commonly detected of the focal marsh bird species in each year, whereas no common gallinules were detected after the pre-construction baseline period and least bitterns were rarely detected. The overall average in

2021 was the lowest since the surveying effort began, whereas the average in 2020 was the highest (8.67 individuals/survey and 11.17 individuals/survey, respectively; Table 11-3). Despite this decline in 2021, the overall focal marsh bird species average has remained relatively similar across years.

Table 11-3. Survey Detections of Other Focal Marsh Bird Species

Focal Species Common Name	Average Number Detected per Survey (Standard Error)				
	2016–2017 Baseline[1]	2018[2]	2019[2]	2020[2]	2021[2]
Virginia Rail	6.00 (1.41)	6.17 (1.70)	7.83 (0.54)	6.83 (1.58)	5.50 (1.82)
Least Bittern	0.33 (0.17)	0.67 (0.42)	0.17 (0.17)	0.17 (0.17)	0.00 (0.00)
American Bittern	0.75 (0.48)	1.00 (0.37)	0.33 (0.33)	2.33 (0.71)	0.83 (0.48)
Common Gallinule	0.08 (0.08)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Pied-billed Grebe	1.75 (0.38)	2.00 (0.82)	2.50 (0.72)	1.83 (0.70)	2.33 (0.42)
All Species[3]	**10.00 (2.49)**	**9.83 (2.02)**	**10.83 (0.79)**	**11.17 (2.80)**	**8.67 (1.65)**

[1] 2016 and 2017 pre-construction baseline averages from SELRP Baseline Monitoring Report (AECOM 2020a)
[2] Mean and standard error for 2018–2021 averages calculated from number of individuals detected during the six surveys.
[3] Values are based on the survey-specific totals (number of individuals of all focal species) detected for surveys 1 through 6 in each year or combination of years.

11.1.4 Discussion

As marsh bird surveys continue to be conducted during the post-construction phase of the project, a running average will be calculated for the 4 most recent years of construction/post-construction surveys and compared to the pre-construction baseline abundance levels to evaluate performance standards as described in the Monitoring Plan.

11.1.4.1 Light-footed Ridgway's Rail

The 2021 LFRR data yielded the second highest survey area density estimate of the 6-year survey period at 0.25 individuals/acre, which is 0.04 individuals/acre higher than both the pre-construction baseline and the construction/post-construction periods, as well as the 2020 mean. The 4-year construction/post-contruction average of 0.21 individuals/acre was equal to the pre-construction baseline average, and the interim and final performance standards were met. These density estimates resulted in lagoon-wide abundance estimates of 64.19 individuals in 2021, 52.66 individuals in 2020, and 62.98 individuals for the pre-construction baseline period. Results from the floating alpha testing method indicated the 4-year construction/post-contruction lagoon-wide abundance average was not significantly lower than 75% of the pre-construction baseline value but it was significantly lower than 95% of the pre-construction baseline value from a statistical perspective. Therefore, while the interim performance standard for LFRR abundance was met, the final performance standard was not.

The 2021 lagoon-wide abundance estimate is comparable to the pre-construction baseline value despite the total amount of preferred habitat occupying only 85% of the pre-construction acreage. Similarly, although the average estimated LFRR density for the 2018–2021 construction/post-construction period was the same as that observed during the pre-construction baseline period of 2016–2017, the lagoon-wide abundance estimate for the construction/post-construction period was lower than the pre-construction baseline period due to less total acreage of preferred habitat available during the construction/post-construction period relative to the pre-construction baseline period. However, the amount of preferred habitat in both the survey area and lagoon-wide increased in both 2020 and 2021 relative to the amount present in 2019, and this trend is expected to continue as the restored vegetation establishes and matures.

Estimated LFRR numbers were at their lowest in 2019, potentially as a result of restoration-related construction activities, but those numbers rebounded in 2020 and 2021. The increase in estimated LFRR numbers in 2020 and 2021 could be the result of a few factors: normal population cycling, recruitment of adults into the lagoon due to available breeding habitat, or increased recruitment of previous years' young due to reduced nest-predation pressure. Predator control efforts from 2018 through 2021 have targeted potential LFRR nest-predators in the lagoon, including racoons, Virgina opossums, and nonnative rats, among others. These efforts may have resulted in higher nest and young survival during those years, which could be contributing to higher LFRR estimates. Moreover, as preferred LFRR habitat becomes established and matures, there will be additional areas for them to occupy.

11.1.4.2 Other Focal Marsh Bird Species

Due to the low number of detections for each of these species, survey estimates were not corrected for detection probabilities, so the reported numbers probably underestimate true abundance of focal marsh bird species. Thus, abundance estimates are not directly comparable to the modeled abundance estimates of LFRR.

The overall average of 8.67 focal marsh bird individuals/survey in 2021 represented a decline relative to the preceeding years and the pre-construction baseline average. Virginia rail, American bittern, and least bittern all exhibited declines in 2021, whereas pied-billed grebes showed a slight increase. No common gallinules were detected in 2021 similar to the other constuction/ post-construction years. These focal marsh birds are not included in the project's performance standards but are surveyed as additional indicators of the lagoon's condition. Post-construction surveys will continue to monitor numbers of these birds moving forward.

11.2 WATERBIRD SURVEYS, INCLUDING WESTERN SNOWY PLOVER AND CALIFORNIA LEAST TERN

11.2.1 Performance Standard

The monitoring of waterbird species (e.g., seabirds, waterfowl, shorebirds, wading birds) that use open water and mudflat habitats in the SELRP study area is a "pre-restoration absolute" monitoring variable. Pre-construction baseline data (defined as those data collected in 2016 and 2017, as summarized in the Baseline Monitoring Report [AECOM 2020a]) and construction/post-construction data metrics are compared using the "floating alpha" method described in Sections 2.1.2 and 2.2.2 of the Monitoring Plan. Other waterbird species, (i.e., birds that utilize open water, mudflat, and sand habitat, excluding western snowy plovers [Charadrius nivosus nivosus] and California least terns [Sternula antillarum browni]) are monitored to provide additional insight into the health and condition of the lagoon but are not included in the performance standards. Performance standards for western snowy plovers and California least terns are included below.

> **Interim standard**: Construction/post-construction 4-year running average number of individuals 75% or greater than that of pre-construction survey data (2016–2017) by year 7 post-construction
>
> **Final standard**: Construction/post-construction 4-year running average number of individuals 95% or greater than that of pre-construction survey data (2016–2017) by year 10 post-construction

Running averages are used to account for annual population variability. Standards will not be considered met until performance standards are met for 3 consecutive years (see Section 2.3 of the Monitoring Plan).

In addition, documentation of western snowy plover or California least tern nesting in the west, central, or east basins would be considered a success since nesting by these species has been absent or sporadic in the lagoon. In 2015, one successful nesting event was observed on Cardiff Beach; however, the beach area nesting conditions are not expected to change as a result of restoration efforts. The *Western Snowy Plover and California Least Tern Nest Monitoring and Management Plan for the San Elijo Lagoon Restoration Project* (AECOM 2017) describes actions to be taken to monitor and manage the nest area being designed as part of the SELRP.

11.2.2 Approach

Waterbird surveys focused on birds that utilize open water, mudflat, and sand habitat, including western snowy plovers and California least terns. A complete description of survey methodology for waterbird surveys can be found in the Monitoring Plan. Each survey yielded a census of waterbirds observed in the west, central, and east basins of the lagoon. Abundances of two species, western snowy plover and California least tern, were calculated as the lagoon-wide average of individuals observed per survey by month, as well as the average number observed per survey within each basin. These values were then used to calculate an overall per-survey average for each year. Observations of other waterbird species were grouped into specific taxonomic orders and summarized as both the number of individuals in each cohort observed per survey by month for each basin, and an overall per-survey average for each year. Detailed approach, as well as results such as lists of the species associated with each taxonomic order detected during surveys in 2020 and 2021, are provided in Appendix H.

In the construction/post-construction period, surveys were conducted January through December with one survey conducted per month during January, February, October, November, and December, and at least two surveys conducted per month during March through September. Because California least terns overwinter in Central and South America and breed in Southern California during May and July, results for California least terns are provided for the months of April through September because the species is generally not present at the lagoon outside of these months.

11.2.3 Results

Detailed summaries of the survey dates, survey times, survey personnel, and weather conditions for 2020 and 2021 are provided in Appendix H.

When multiple surveys were conducted in a month for a given year, the mean number of individuals detected across surveys conducted in that month was calculated. The mean number of individuals detected per survey during each month was used to evaluate temporal variation in abundance (across seasons and years), and to calculate the overall annual average abundance metrics. Survey results from 2020 and 2021 are also summarized by lagoon basin in Appendix H.

11.2.3.1 Western Snowy Plover

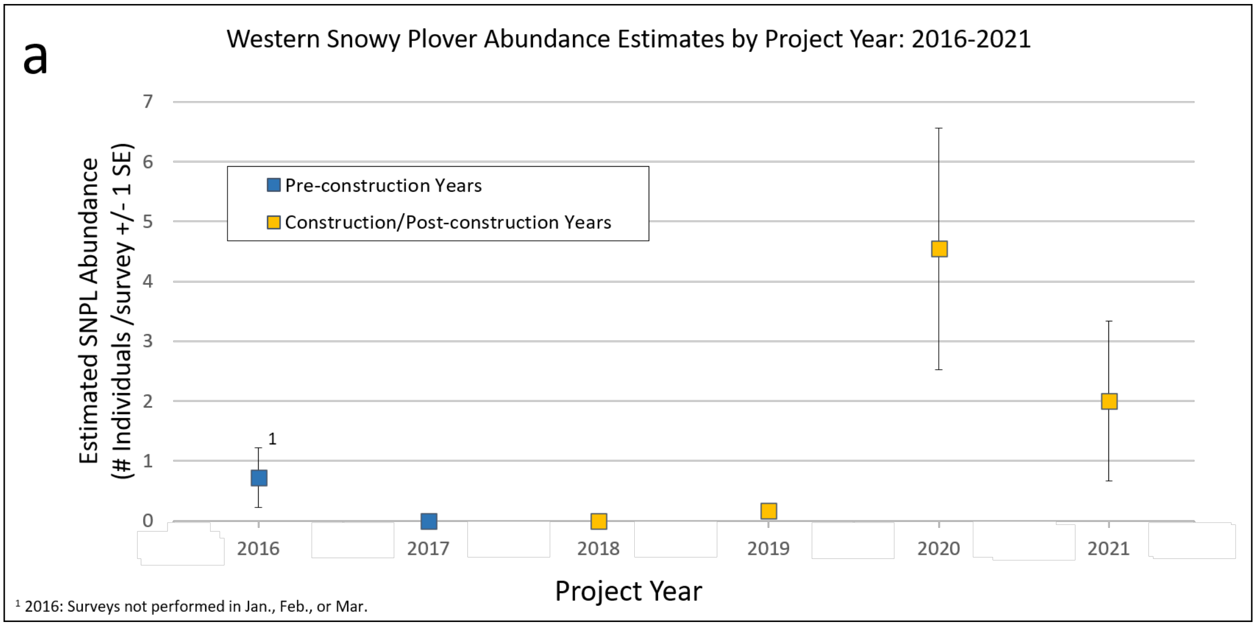
Locations of western snowy plover detections from 2020 and 2021 surveys are depicted in Appendix H. Results from western snowy plover surveys from the pre-construction baseline period and 2018–2021 are summarized by month in Table 11-4. Western snowy plovers were detected in low numbers each year, with the exceptions of 2017 and 2018, during which no birds were detected. In general, no western snowy plovers were detected in the months of February through June in any year (Table 11-4). Results from the floating alpha testing method indicated the 4-year construction/post-construction average was not significantly lower than 75% of the pre-construction baseline mean, nor was it significantly lower than 95% of the pre-construction baseline mean (Table 11-4; Figure 11-3a & Figure 11-3b). Thus, both the interim and final performance standards were met for western snowy plover abundance (Figure 11-3b).

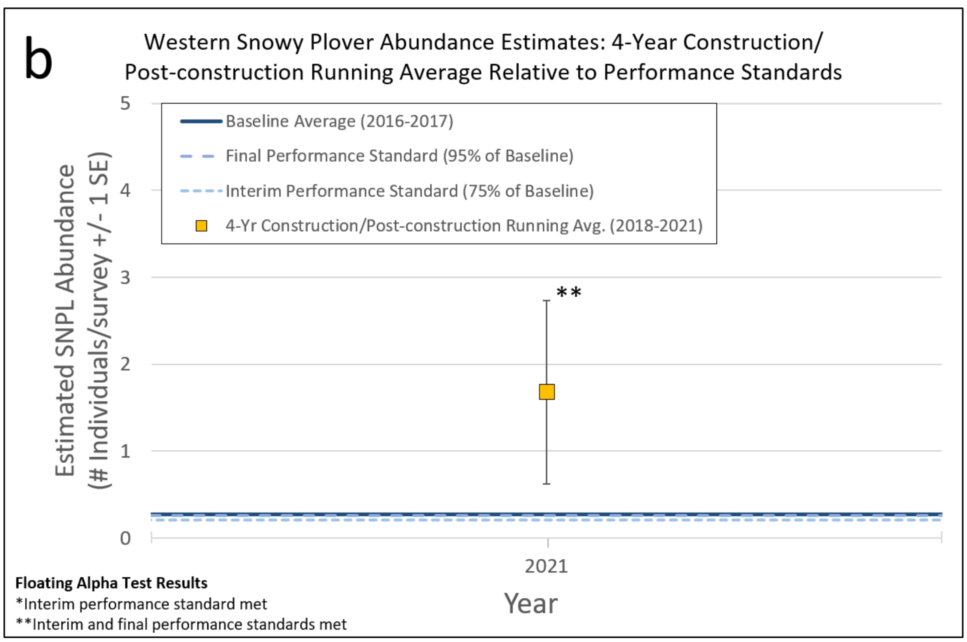
Table 11-4. Summary of Western Snowy Plover Results by Month

Monthly Averages (Mean # Individuals/Survey)						
Month	**2016–2017 Baseline**	**2018**	**2019**	**2020**	**2021**	**4-year Construction/ Post-construction Running Average[1]**
Jan	0.00	0.00	0.00	18.00	0.00	4.50
Feb	0.00	0.00	0.00	0.00	0.00	0.00
Mar	0.00	0.00	0.00	0.00	0.00	0.00
Apr	0.00	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.50	7.50	2.00
Aug	0.00	0.00	1.00	0.00	0.50	0.38
Sep	1.25	0.00	0.00	3.00	1.00	1.00
Oct	2.00	0.00	0.00	5.00	0.00	1.25
Nov	0.00	0.00	1.00	10.00	0.00	2.75
Dec	0.00	0.00	0.00	18.00	15.00	8.25
Overall Average (Standard Error)	**0.27 (0.19)**	**0.00 (0.00)**	**0.17 (0.11)**	**4.54 (2.01)**	**2.00 (1.33)**	**1.68 (0.72)**

[1] The 4-year construction/post-construction running average is from 2018–2021.

Figure 11-3. Western Snowy Plover Abundance Performance Standards Test Results





11.2.3.2 California Least Tern

Locations of California least tern detections from 2020 and 2021 surveys are depicted in Appendix H. Results from California least tern surveys are provided only for the months of April through September because the species is generally not present on their breeding grounds outside of this date range. Results from the pre-construction baseline period and 2018–2021 surveys are summarized by month below (Table 11-5). Lagoon-wide, California least terns were not detected during surveys conducted in the months of April, August, or September, and their numbers tended to be highest during June and July.

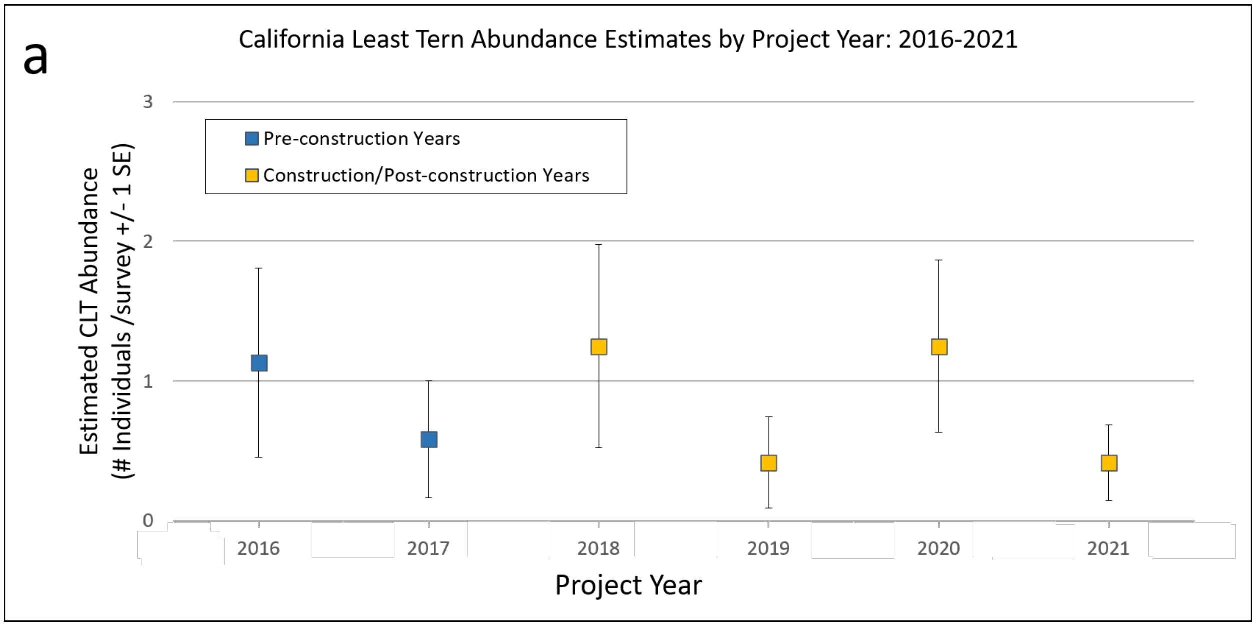
California least terns were detected in low numbers each year, with monthly averages ranging from 0.42 individuals/survey in 2019 and 2021, to 1.25 individuals/survey in 2018 and 2020 (Table 11-5). The 4-year construction/post-construction average was 0.83 individuals/survey, which was slightly lower than the pre-construction baseline average of 0.86 individuals/survey (Table 11-5; Figure 11-4a & Figure 11-4b). Results from the floating alpha testing method indicated the 4-year construction/post-construction average was not significantly lower than 75% of the pre-construction baseline mean, nor was it significantly lower than 95% of the pre-construction baseline mean. Thus, both the interim and final performance standards were met for California least tern abundance (Figure 11-4b).

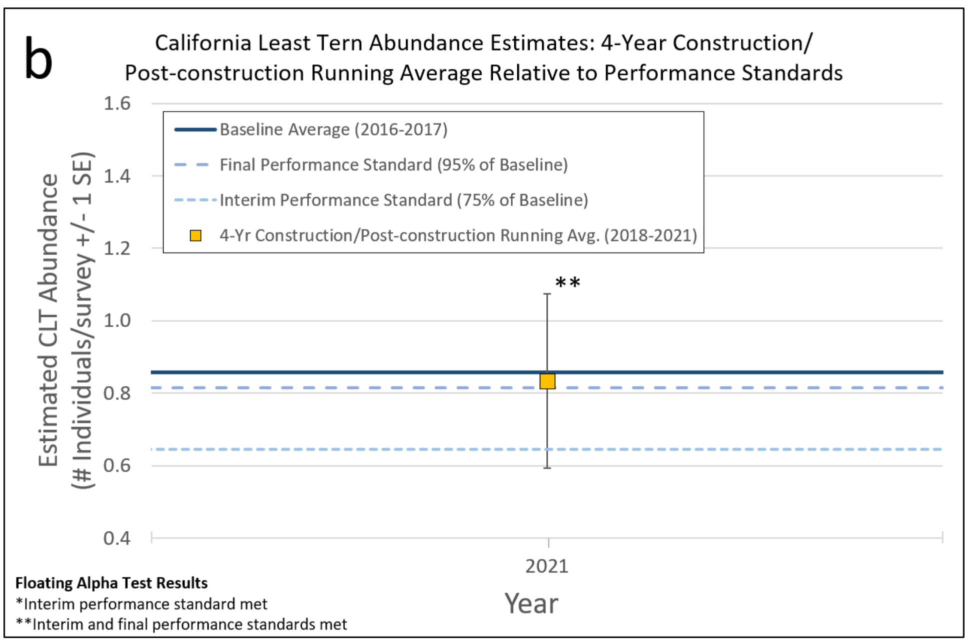
Table 11-5. Summary of California Least Tern Results by Month

Monthly Averages (Mean # Individuals/Survey)						
Month	**2016–2017 Baseline**	**2018**	**2019**	**2020**	**2021**	**4-year Construction/ Post-construction Running Average[1]**
Apr	0.00	0.00	0.00	0.00	0.00	0.00
May	1.40	0.50	0.50	1.50	0.00	0.83
Jun	3.35	4.00	2.00	3.50	1.00	3.17
Jul	0.40	3.00	0.00	2.50	1.50	1.83
Aug	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00
Overall Average (Standard Error)	**0.86 (0.55)**	**1.25 (0.73)**	**0.42 (0.33)**	**1.25 (0.62)**	**0.42 (0.27)**	**0.83 (0.45)**

[1] The 4-year construction/post-construction running average is from 2018–2021.

Figure 11-4. California Least Tern Abundance Performance Standards Test Results





11.2.3.3 Other Waterbird Species

Results from the pre-construction baseline period and 2018–2021 surveys are summarized by month below (Table 11-6). The lagoon-wide survey average increased each year following the pre-construction baseline period through 2020, and then dipped in 2021 to 2019 levels (Table 11-6). Detections in 2021 (663.58 individuals/survey) were very close to the 4-year construction/post-construction average of 661.19 individuals/survey, and approximately 85% higher than the pre-construction baseline average of 355.8 individuals/survey. Waterbird numbers tended to be lower during the months of May through August, coincident with the time that most winter migrants are away at breeding grounds farther north.

Table 11-6. Summary of Waterbird Results by Month

Monthly Averages (Mean # Individuals/Survey)					
Month	**2016–2017 Baseline**	**2018**	**2019**	**2020**	**2021**
Jan	509.5	745.0	698.0	1,275.0	1,284.0
Feb	857.0	1,037.0	622.0	1,310.0	1,476.0
Mar	458.5	590.5	872.0	690.0	729.5
Apr	328.8	385.5	415.5	501.0	349.5
May	181.3	339.0	212.5	412.0	143.0
Jun	148.9	61.0	225.5	258.5	88.0
Jul	154.8	194.0	383.0	595.5	316.0
Aug	262.0	274.0	399.0	424.5	446.5
Sep	286.8	288.0	526.0	621.0	471.5
Oct	186.5	451.0	796.0	868.0	821.0
Nov	549.8	408.0	1,194.0	1,717.0	692.0
Dec	682.8	662.0	1,751.0	1,572.0	1,146.0
Overall Average (Standard Error)	**355.8 (72.7)**	**452.92 (77.29)**	**647.54 (127.65)**	**853.71 (141.76)**	**663.58 (129.49)**

The two orders of birds most frequently observed during waterbird surveys were the Anseriformes (waterfowl) and Charadriiformes (shorebirds, gulls, and terns). Waterbirds belonging to these two taxonomic orders comprised more than 80% of all observations in each year. Because both groups consist largely of migrant species that overwinter in the area or pass through when traveling between winter and breeding grounds, seasonal variation in overall waterbird numbers are largely driven by differences in the abundance of these two groups through the year.

11.2.4 Discussion

11.2.4.1 Western Snowy Plover

During 2020 and 2021, western snowy plovers were observed within the lagoon in modest numbers in the west and central basins. In both years, the bulk of detections occurred in December and January, with fewer but somewhat consistent detections in the summer and fall months (Table 11-4). The 4-year construction/post-construction average of 1.68 individuals/survey was over 6 times higher than the pre-construction baseline average of 0.27 individuals/survey, and both the interim and final performance standards were met for western snowy plover abundance (Figures 11-3a & 11-3b).

Over the course of the project, western snowy plovers have been detected most consistently in the west basin, except for 2017 and 2018 when no western snowy plovers were detected in any basin. Construction-related dredging activities have resulted in an increase in the amount of open mudflat foraging habitat in the central basin, and it appears that the western snowy plovers have begun utilizing that area for foraging in greater numbers. While this habitat type is abundant and available immediately post-construction, some of this may dissipate over time as restored vegetation takes hold. Western snowy plovers generally favor sandy substrate for foraging, but they will readily forage on mudflats and other unvegetated flats as well. Trends for western snowy plover habitat usage in the lagoon should become clearer as additional data are collected.

11.2.4.2 California Least Tern

California least terns were present in low numbers during the months of June and July in 2021. Overall, the number of California least tern detections during 2021 was 0.42 individuals/survey, which was approximately one-third of the 2020 numbers and identical to the 2019 average (Table 11-5). The 2021 average was about half the 4-year construction/post-construction average, as well as the pre-construction baseline average (0.83 individuals/survey and 0.86 individuals/survey, respectively). Although the 4-year construction/post-construction average was slightly lower than the pre-construction baseline average, results from the floating alpha testing method indicated it was not significantly lower than 95% of the pre-construction baseline value or 75% of the pre-construction baseline value from a statistical perspective. Therefore, both the interim and final performance standards were met for California least tern abundance (Figure 11-4a & Figure 11-4b).

California least terns have not been abundant in the lagoon for the past several years. Based on monthly counts conducted at the lagoon 1973–1983, and again from 2002–2017, California least tern numbers were substantially higher 10–20 years ago, with monthly counts as high as 69 and 78 individuals in 2004 and 2007, respectively (Nature Collective 2020). In 2020, 15 California least terns were detected in the lagoon, but the 2021 total count of five birds is the same as that of 2019 (2018–2019 Avian Monitoring Report [AECOM 2020b]). These data suggest that California least terns are still relatively uncommon lagoon users, and that interannual variation in survey detections may be more reflective of sampling error than actual trends in habitat usage. Increased tidal flow due to restoration work may improve foraging conditions, and 4 acres of protected sand dunes should provide safe nesting habitat, both of which could bolster California least tern numbers in the lagoon moving forward.

11.2.4.3 Other Waterbird Species

Waterbird surveys were designed to assess the abundance of waterbird species (e.g., seabirds, waterfowl, shorebirds, wading birds) that use open water and mudflat habitats in San Elijo Lagoon. The 2021 survey numbers (663.58 individuals/survey) remained much higher than pre-construction baseline levels (355.8 individuals/survey) but showed a drop-off relative to 2020 (853.71 individuals/survey). Waterbirds are not included in the project's performance standards but are surveyed as additional indicators of the lagoon's condition. Post-construction surveys will continue to monitor numbers of these birds moving forward.

11.3 BELDING'S SAVANNAH SPARROW SURVEYS

11.3.1 Performance Standard

The monitoring of Belding's savannah sparrows (*Passerculus sandwichensis beldingi*) is a "pre-restoration absolute" monitoring variable and is not compared to reference wetlands for purposes of determining success of the SELRP. Pre-construction data and construction/post-construction data metrics are compared using the "floating alpha" method described in Sections 2.1.2 and 2.2.2 of the Monitoring Plan. Performance standards for Belding's savannah sparrows are included below.

> **Interim standard**: Construction/post-construction 4-year running average density 75% or greater than that of pre-construction survey data (2016–2017) by year 7 post-construction
>
> **Final standard**: Construction/post-construction 4-year running average density 95% or greater than that of pre-construction survey data (2016–2017) by year 10 post-construction

Running averages are used to account for annual population variability. Standards will not be considered met until performance standards are met for 3 consecutive years (see Section 2.3 of the Monitoring Plan).

11.3.2 Approach

The focus of these surveys was to estimate density for the state endangered Belding's savannah sparrow. Per the Monitoring Plan, survey results are summarized according to the following four "survey periods" designed to enable grouping of survey results across four roughly equal time periods and to minimize the effects temporal variation may have on analysis results, Belding's savannah sparrow detections were recorded at all distances from the survey transects measuring 100 m long located within suitable habitat and spread throughout the lagoon, following methods described in the Monitoring Plan. Initially, there were 19 transects (i.e., transects 1 through 19), with transects 1 through 4, 6, 9, and 11 through 15 surveyed only on one side due to the lack of sufficient suitable habitat on the other side. Starting in 2019, transects 16 and 17 could no longer be surveyed due to safety issues. Detailed summaries of the survey dates, survey times, survey personnel, and weather conditions for 2020 and 2021 are provided in Appendix H.

Survey data were analyzed using a distance sampling approach (Buckland et al. 2001), which applied the distances between the observer and each detected bird to control for differences in detectability. Based on results from the distance sampling model approach (Buckland et al. 2001) and data collected in previous years, detections beyond 75 m perpendicular distance from the transect were omitted from the analysis. An estimate of the density of Belding's savannah sparrow individuals was calculated for each survey as the number of individuals per acre across the survey area as a whole. The model selection process was revised following the 2020 season to better fit the distribution of the data. To ensure appropriate comparisons across years, this change was also applied to the previous years' data (2016–2019), resulting in modest changes to the annual estimates for the pre-construction baseline and first two construction year periods (Appendix H).

11.3.3 Results

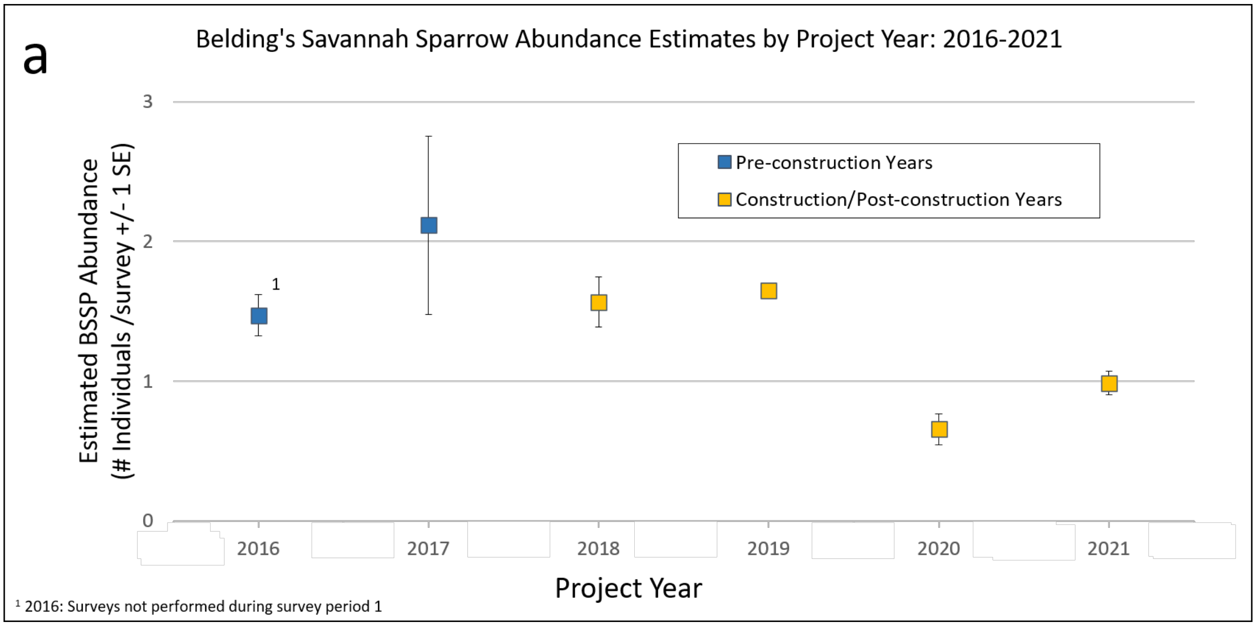
Belding's savannah sparrows were detected primarily in areas dominated by CSM – Low, CSM – Mid, and CSM – High in 2020 and 2021, as shown in Appendix H. Belding's savannah sparrow density within the survey area was higher in 2021 than the 2020 average (Table 11-7) but was lower than other years from 2016 through 2019. The 4-year construction/post-construction average from 2018–2021 (1.23 individuals/acre) was substantially lower than the 2016–2017 pre-construction baseline average (2.11 individuals/acre) (Table 11-7). Results from the floating alpha testing method indicated the 4-year construction/post-construction average was significantly lower than 75% of the pre-construction baseline mean and 95% of the pre-construction baseline mean (Table 11-7; Figure 11-5a & Figure 11-5b). Thus, neither the interim nor the final performance standard was met for Belding's savannah sparrow density (Figure 11-5b).

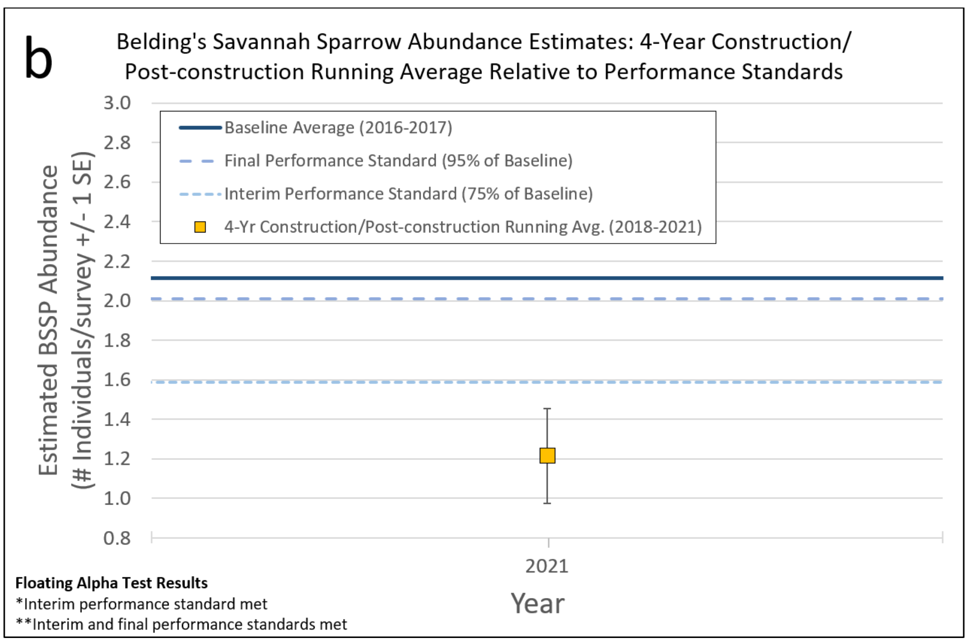
Table 11-7. Summary of Belding's Savannah Sparrow Results by Survey Period

Survey Period Averages (Density [Mean # Individuals/acre])						
Survey Period	**2016–2017 Baseline[1]**	**2018**	**2019**	**2020**	**2021**	**4-year Construction/ Post-construction Running Average[2]**
Late-Feb to Mid-Mar	4.03	2.01	1.57	0.89	1.07	1.38
Late-March to Early-Apr	1.61	1.64	1.63	0.38	1.18	1.21
Mid-Apr to Late-Apr	1.45	1.16	1.70	0.76	0.87	1.12
Early-May to Mid-May	1.36	1.46	1.70	0.59	0.82	1.14
Overall Average (Standard Error)	**2.11 (0.64)**	**1.57 (0.18)**	**1.65 (0.03)**	**0.66 (0.11)**	**0.98 (0.08)**	**1.21 (0.06)**

[1] Pre-construction Baseline values differ from those reported in previous reports due to revised model selection approach in estimating survey area densities (see Section 2.3.2 and Appendix H).
[2] The 4-year construction/post-construction running average is from 2018–2021.

Figure 11-5. Belding's Savannah Sparrow Abundance Performance Standards Test Results





11.3.4 Discussion

The estimated Belding's savannah sparrow density within the survey area was higher in 2021 than in 2020. The 4-year construction/post-construction average was markedly lower than the pre-construction baseline average, and neither the interim nor final performance standard was met for Belding's savannah sparrow abundance (Figure 11-5a & Figure 11-5b).

The Belding's savannah sparrow density estimate in the pre-construction baseline period was heavily driven by one unusually high estimate from the first survey period in 2017 (see Baseline Monitoring Report [AECOM 2020a]). That 2017 first survey period estimate (4.03 individuals/acre) is more than twice as high as any other survey from 2016 through 2021, all of which were less than 2.01 individuals/acre (Table 11-7). No surveys were performed during the first survey period in 2016, so the pre-construction baseline estimate for that survey period is based solely on the unusually high 2017 density estimate (Table 11-7; Appendix H). If the first survey period estimate that is twice as high is considered an outlier and omitted from the analysis, results from the floating alpha testing method indicate that the 4-year construction/post-construction average meets the interim performance standard but not the final performance standard. This is the case whether the first survey period estimates are included in the 4-year construction/post-construction average or omitted (to provide a balanced comparison between periods). The higher estimated density in the pre-construction baseline period was heavily driven by one unusually high estimate from the first survey in 2017 (see Baseline Monitoring Report [AECOM 2020a]). Aside from that high count, density estimates for each survey period have fallen between 1.00 and 2.01 individuals/acre with the exception of all survey periods in 2020 and the last two surveys in 2021, when density estimates were lower than 1.00 individuals/acre (Table 11-7).

The reduced Belding's savannah sparrow density estimates in 2020 and 2021 (relative to the previous years) likely reflect losses in Belding's savannah sparrow preferred habitat due to channel widening and changes in vegetation composition. However, some areas of mudflat are transitioning to CSM – Low, and Belding's savannah sparrow numbers may increase as this transition occurs and once CSM – Low becomes more established. As Belding's savannah sparrow surveys continue to be conducted during the post-construction phase of the project, running averages will continue to be calculated annually for the species' density within the survey area for the 4 most recent years of construction/post-construction surveys, and will be compared to the pre-construction baseline density levels to evaluate interim and final performance standards.

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12. WETLAND FUNCTION

12.1 PERFORMANCE STANDARD

Wetland function is an absolute monitoring variable and is not compared to reference wetlands for purposes of determining success of the SELRP. The individual assessment areas (AAs) California Rapid Assessment Method (CRAM) scores and averaged lagoon CRAM score are used to compare post-restoration conditions to pre-restoration conditions and function of the lagoon. This average score serves as the reference for determining the success of the restoration activities. Table 12-1 contains the CRAM performance standards.

Table 12-1. CRAM Performance Standards

CRAM Score	Expected Results	Performance Standard	Year
Buffer and Landscape Context Attribute	Not expected to change, mostly outside the scope of the SELRP	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Hydrology Attribute	Expected to increase slightly due to dredging and topography changes to increase tidal flow and flushing	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Physical Structure Attribute	Expected to recover to equal or exceed Baseline condition	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Biotic Structure Attribute	Expected to recover to equal or exceed Baseline condition	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Overall CRAM	**Expected to recover to equal or exceed Baseline condition**	**Post-Restoration ≥ Baseline CRAM Overall Score**	**Year 5**

CRAM = California Rapid Assessment Method; SELRP = San Elijo Lagoon Restoration Project

12.2 APPROACH

In September 2016, AECOM CRAM-certified practitioners conducted the pre-construction CRAM assessment. The CRAM assessment was performed following the current guidelines, version 6.1 (CWMW 2013a) and the field book of the appropriate wetland module (CWMW 2013b, 2013c). There were 25 AAs used for the 2016 baseline condition assessment. No CRAM assessment was completed in 2020. In August 2021, AECOM and Nature Collective CRAM-certified practitioners conducted the first post-construction CRAM assessment. The CRAM assessment was performed following the latest guidelines, version 6.1 (CWMW 2013a) and the field book of the appropriate wetland module (CWMW 2013b, 2013c). There were 24 AAs used for the 2021 post-construction assessment. The removal of one AA was necessary since the pre-restoration location of the AA was in a location that became entirely open channel post-restoration and was no longer a suitable AA. A complete description of survey methodology, and CRAM assessment and scoring can be found in the Monitoring Plan. Moreover, in accordance with Clean

Water Act Section 401 Certification requirements, photographs of the lagoon were taken to document pre-restoration and post-restoration conditions (Appendix I).

12.3 RESULTS

In 2016, CRAM scores ranged from a low of 60 to a high of 85. Two different wetland types, and therefore two different modules, were used for the assessment: estuarine and depressional. The majority of the AAs (20) were estuarine wetlands, found in the west, central, and westernmost portions of the east basin. However, five AAs in the east basin did not fit the CRAM definition of estuarine wetland and were assessed using the depressional module.

The 2016 pre-construction average scores for each CRAM attribute are provided in Table 12-2. Detailed results for each AA are provided in Appendix J.

Table 12-2. 2016 Average CRAM Attribute Scores by Wetland Type

Attribute	Estuarine	Depressional	Estuarine & Depressional (± Standard Error)
Buffer & Landscape Connectivity	85.65	93.40	87.20 ± 2.23
Hydrology	58.70	79.80	62.92 ± 2.10
Physical Structure	71.00	45.20	65.84 ± 3.48
Biotic Structure	74.55	84.80	76.60 ± 2.04
Overall Assessment Area Score	**72.30**	**75.80**	**73.00 ± 1.21**

CRAM = California Rapid Assessment Method

In 2021, individual AA CRAM scores ranged from a low of 61 to a high of 92. Following the pre-restoration methodology, two different wetland types, and therefore two different modules, were used for this assessment: estuarine and depressional. The majority of the AAs (19) were estuarine wetlands, found in the west, central, and westernmost portions of the east basin. However, five AAs in the east basin did not fit the CRAM definition of estuarine wetland and were assessed using the depressional module.

The highest scoring AA was C48, an estuarine AA in the central basin. The lowest scoring AAs were the estuarine AAs C33 (central basin) and W-4 (west basin) with a 61 and 63 overall score, respectively. The 2021 post-construction average scores for each CRAM attribute are provided in Table 12-3. Detailed results for each AA are provided in Appendix J.

Table 12-3. 2021 Average CRAM Attribute Scores by Wetland Type

Attribute	Estuarine	Depressional	Estuarine & Depressional (± Standard Error)
Buffer & Landscape Connectivity	86.16	92.80	87.54 ± 2.28
Hydrology	60.53	80.40	64.67 ± 2.04
Physical Structure	69.37	42.80	63.83 ± 4.43
Biotic Structure	71.05	74.20	71.71 ± 2.55
Overall Assessment Area Score	**72.21**	**72.60**	**72.29 ± 1.36**

CRAM = California Rapid Assessment Method

The average attribute scores and overall CRAM scores for the lagoon are provided in Table 12-4. Table 12-4 indicates that the lowest scores were received in the hydrology and physical structure attributes and associated metrics.

Table 12-4. Average Attribute and Overall CRAM Scores

CRAM Attributes	Pre-Restoration Average CRAM Score (%)	Year 1 - Restoration Average CRAM Score (%)	Relative Change (%)
Buffer and Landscape Context	87	88	0.4%
Hydrology	63	65	2.4%
Physical Structure	66	64	-3.2%
Biotic Structure	76	72	-6.1%
Overall CRAM Score	**73**	**72**	**-1.0%**

CRAM = California Rapid Assessment Method

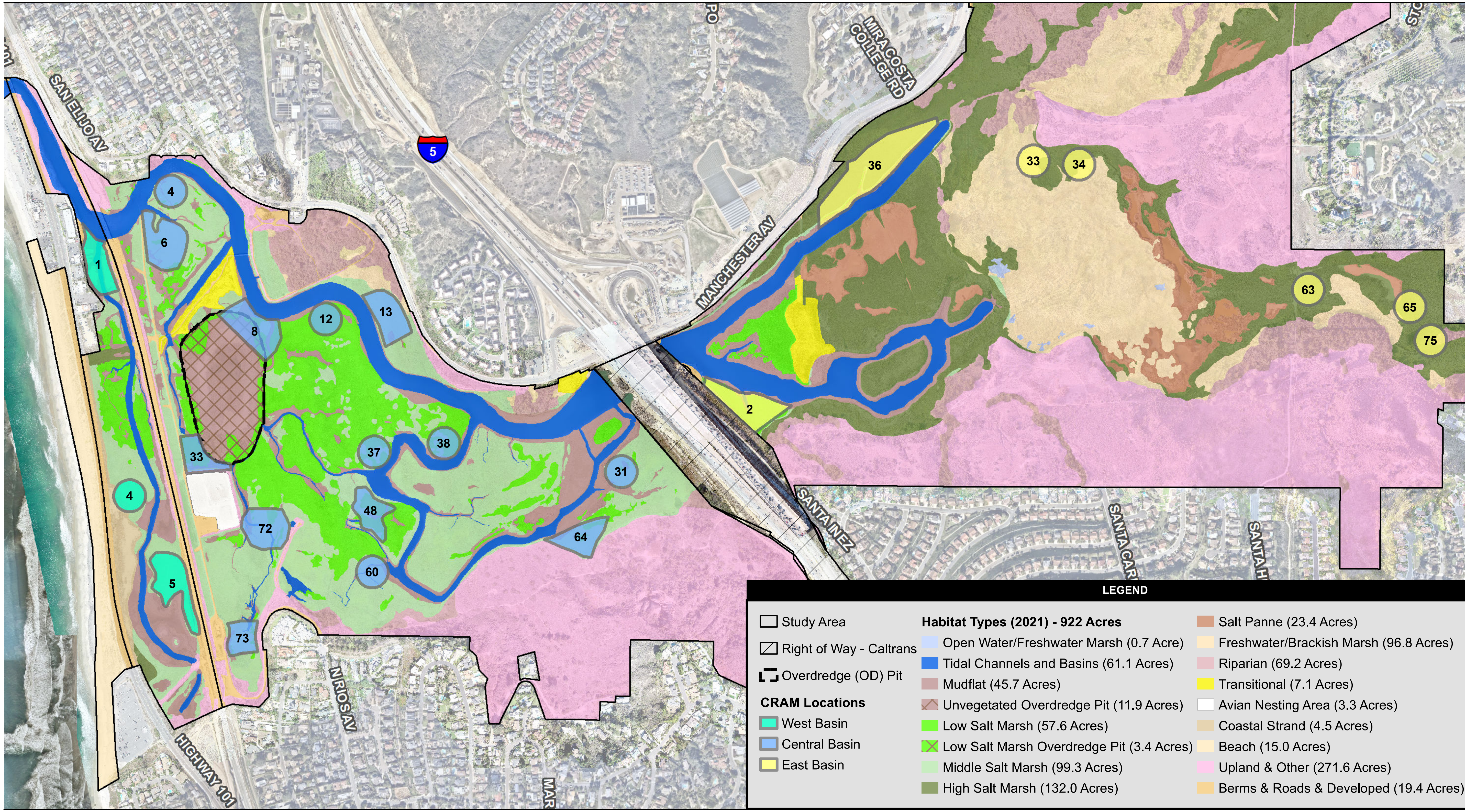
12.4 DISCUSSION

The average overall CRAM scores varied slightly between pre- and post-restoration assessments (Table 12-4), suggesting that the restoration implementation activities had the anticipated effects on wetland condition across San Elijo Lagoon. The Hydrology attribute experienced the biggest positive change in average overall attribute score (+2.4%, Table 12-4) from pre-restoration conditions, with increases mainly in hydroperiod and hydrological connectivity metrics, whereas Biotic Structure scored the greatest decrease in the average overall attribute score from pre-restoration conditions with -6.1%. Positive changes in the Biotic Structure of individual AAs are anticipated as the restoration program progresses, resulting in smaller differences between pre- and post-restoration assessment in subsequent years.

Year 1 post-restoration CRAM score results confirmed the lack of significant change in Buffer and Landscape Context attribute/metric scores after restoration implementation. Within the Hydrology attribute, Water Source is influenced by the level of development surrounding the lagoon and did not change after restoration. However, Hydroperiod and Hydrological Connectivity metric scores increased after restoration, resulting in a 2.4% increase from pre-restoration conditions in the average overall Hydrology attribute. Areas that have been planted or are expected to convert and reside within one of these AAs are most likely to increase the attribute/metric scores for the Physical Structure and Biotic Structure attributes as the vegetation increases in cover and diversity; however, current wetland condition scores for these two attributes are still below the pre-restoration levels observed in 2016 (AECOM 2016).

Almost 70% of all CRAM metric/submetric scores recorded during Year 1 restoration for the SELRP AAs were A or B, almost matching the percentage observed during the pre-restoration CRAM monitoring in 2016 (70.5%). Other than a few outliers, current CRAM scores for the 24 AAs included in this analysis are consistent with the Year 1 post-restoration expectations; in fact, the frequency of the score of A was slightly higher during Year 1 than in pre-restoration assessment. Based on the results of this CRAM analysis, the Buffer and Landscape Context and Hydrology attributes are not expected to change significantly while the Physical Structure and Biotic Structure attributes are expected to increase in score as the vegetation in planted and areas expected to convert fills in.

When comparing the overall AA scores for estuarine and depressional wetland types between 2016 and 2021, the depressional scores are slightly higher than the estuarine scores for both years. If comparing the depressional scores between 2016 and 2021, the 2016 scores are several points higher. This is most likely related to several years of drought as these AAs are all in fairly high and dry locations that rely entirely on seasonal rain. These AAs will only be affected by the project improvements in the very long term and sea level rise over time. When comparing the scores for the estuarine AAs between 2016 and 2021, the scores are the same at 72; therefore, the project is considering the performance standard for CRAM to be met.



MoffattNichol (2015-18); AECOM (2018-2021), SanGIS (2018).

800 400 0 800 Feet

Scale: 1:9,600; 1 inch = 800 feet

Figure 12-1
CRAM Locations and Habitats 2021

Path: L:\DCS\Projects_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Report\Annual\CRAM_Annual_Report_Habitat_Types_2021_11x17.mxd, 7/19/2022, paul.moreno

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13. EELGRASS

13.1 PERFORMANCE STANDARD

Eelgrass is an absolute standard in which pre-restoration conditions are compared to post-restoration conditions. If, after the post-restoration surveys are completed, eelgrass has reestablished and no permanent losses are documented, the project will have met performance standards. Pre-restoration conditions are shown in Table 13-1.

Table 13-1. Eelgrass Bed Metrics for Pre-construction Eelgrass Survey – October 2017.

Location	Spatial Distribution	Eelgrass Areal Extent	Vegetated Cover	Percent Cover
San Elijo Lagoon	716 m^2	19 m^2	0.9 m^2	4.7 %

m^2 = square meter(s)

13.2 APPROACH

Due to localized dredging that was conducted into 2021 to remove shoaling prior to completion of the I-5 channel widening, formal post-construction surveys to confirm whether the project meets the performance standard are anticipated in 2022, per Special Condition 36 of the Section 404 permit issued by the Corps. For information purposes, Nature Collective conducted surveys for eelgrass during 2020 and 2021. Nature Collective conducted an initial survey on March 6, 2020, to inform locations for potential additional dredging that may occur prior to completion of construction of the I-5 freeway improvements. The survey was conducted by three teams of two snorkel surveyors each running parallel transects across the study area. Eelgrass patch location and size data were mapped by each team and aggregated into a single map. The estimates are conservative due to high turbidity at the time of the survey; because of low visibility, some areas could not be mapped.

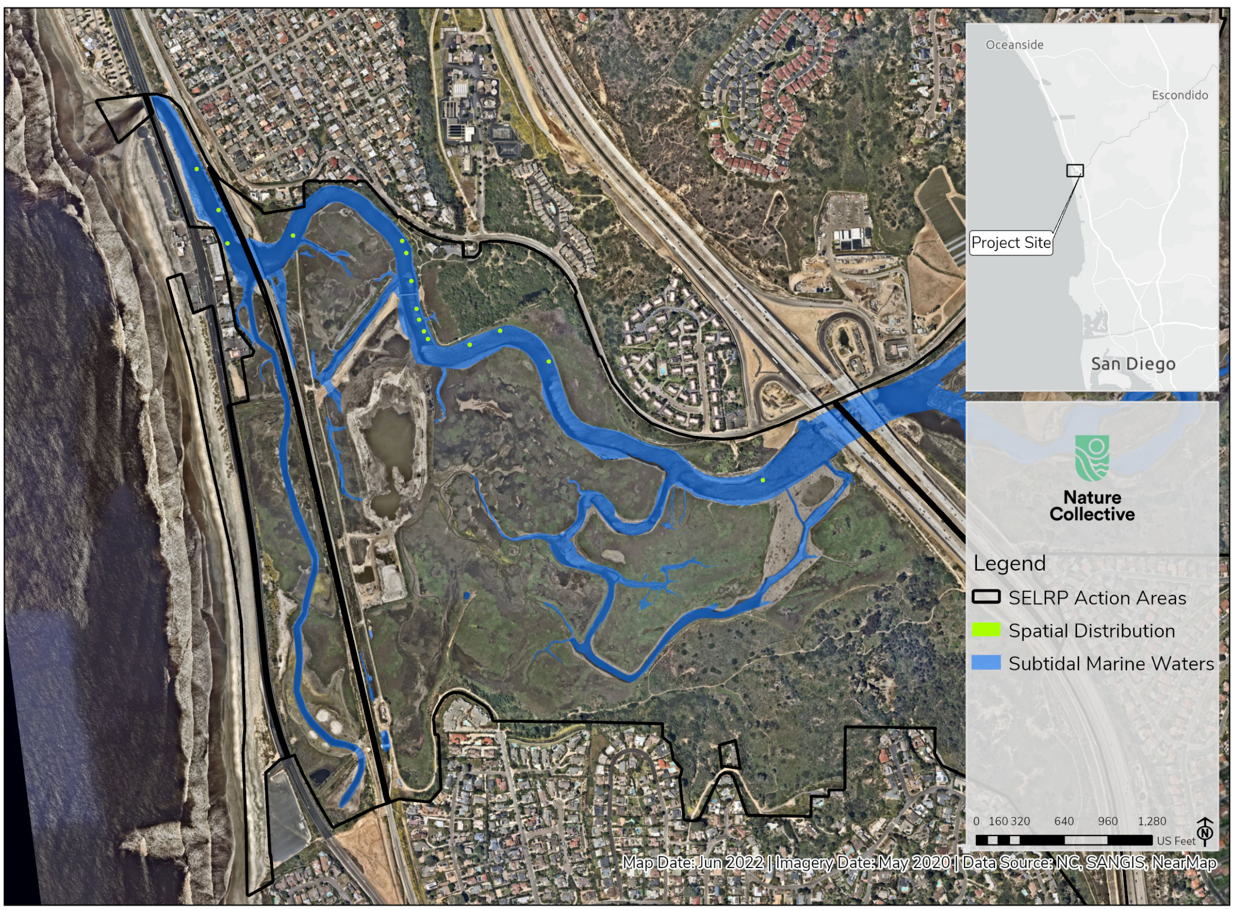
Nature Collective conducted a second supplemental survey in September 2021. The post-construction eelgrass survey was conducted by a team of snorkelers along the shallow and deep portions of the lagoon channel during low tide. A team of four snorkelers and one recorder allowed for sufficient coverage of the channel width while accommodating for overlap in the snorkelers' field of view. The survey navigated from the lagoon inlet and then south and east up to the I-5 crossing. Data were collected in WGS 1984 Web Mercator (auxiliary sphere) in meters (Universal Transverse Mercator [UTM]) using ESRI's Field Map software (ESRI 2021). Following completion of the survey, the data were processed in ESRI's ArcGIS Pro and plotted on a geo-rectified aerial image of the project site sourced in the same month of the survey (ESRI 2021) (September, NearMap 2021).

13.3 RESULTS

Results showed patches of eelgrass detected in the inlet channel west of the railroad and in the main channel of San Elijo Lagoon up to the I-5 freeway bridge in 2020. During the 2020 snorkel survey, 19 m^2 of vegetative eelgrass cover was mapped. Distribution from the survey is illustrated in Figure 13-1.

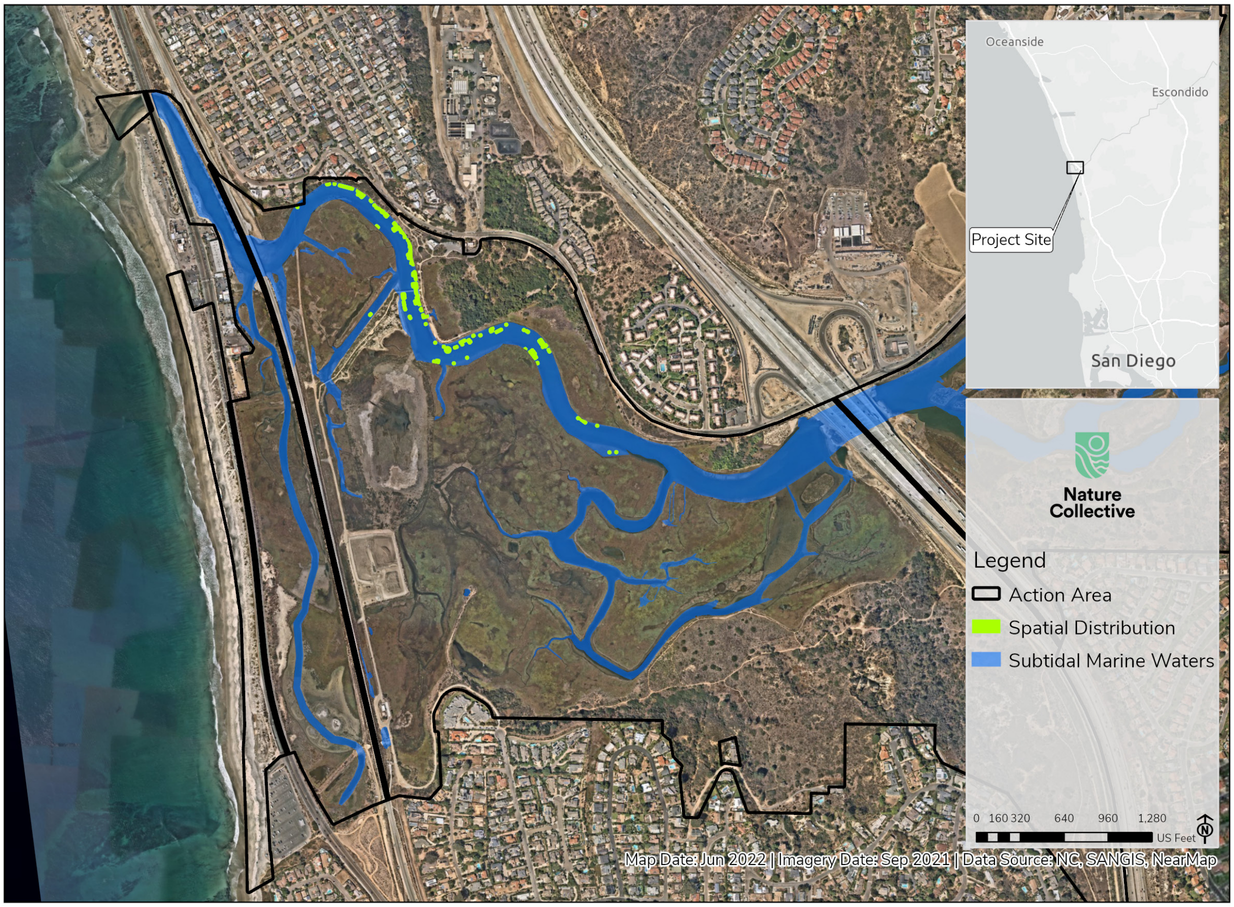
Results showed eelgrass throughout the main channel of San Elijo Lagoon east of the railroad up to the I-5 freeway bridge in 2021. During the 2021 snorkel survey, 221 m^2 of vegetative eelgrass cover was mapped. Distribution from the survey is illustrated in Figure 13-2 and summarized in Table 13-2.

Figure 13-1. Mid-construction Eelgrass Survey – March 2020



Mid-construction Eelgrass Survey - March 2020 - San Elijo Lagoon Restoration Project

Figure 13-2. Post-construction Eelgrass Survey – September 2021



Post-construction Eelgrass Survey - September 2021 - San Elijo Lagoon Restoration Project

Table 13-2. Eelgrass Bed Metrics for Post-construction Eelgrass Survey – September 2021

Location	Spatial Distribution	Eelgrass Areal Extent	Vegetated Cover	Percent Cover
San Elijo Lagoon	7,907 m^2	743 m^2	221 m^2	29.7 %

m^2 = square meter(s)

13.4 DISCUSSION

Eelgrass was observed in small to medium patches and thickly vegetated in the 2020 snorkel survey. A dense 3-m^2 patch of eelgrass was easily observable north of the pedestrian bridge next to the Nature Center in 2020. The 2021 survey results show even further natural recruitment and robust growth from the 2020 results. The 19 m^2 and 221 m^2 of eelgrass vegetative cover mapped in 2020 and 2021, respectively, is substantially larger than the 0.9 m^2 of vegetative cover documented during the 2017 pre-construction surveys. Results show eelgrass has reestablished and no permanent losses have been documented; therefore, the performance standard has been met.

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14. CAULERPA

14.1 PERFORMANCE STANDARD

Performance standards for *Caulerpa* are to confirm that *Caulerpa* is not present within the project site, and there would be no risk for introduction to other sites by project implementation.

14.2 APPROACH

Caulerpa surveys were conducted in September 2021 concurrently with the eelgrass surveys discussed in Chapter 13.

14.3 RESULTS

Caulerpa was not detected during surveys within the project area in 2021.

14.4 DISCUSSION

Caulerpa is not present within the project site; therefore, the project meets the performance standard.

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15. SUMMARY OF PERFORMANCE

15.1 DETERMINING YEAR 1 SUCCESS

The status of the SELRP at the end of Year 1 (2021) is presented in Table 15-1 and Table 15-2 below. Performance standards for topography, bathymetry, tidal elevations, habitat areas, vegetation cover, exotics cover, wetland function, eelgrass, and *Caulerpa* were met. Avian thresholds for breeding marsh birds with focus on LFRR, western snowy plover, and California least tern were also met in 2021. Performance standards for water quality, benthic invertebrates, and fish could not be fully evaluated yet as additional years of data are needed to calculate the 4-year running average. Data are provided in Chapters 7, 8, and 10 as an early indicator of how restoration has impacted metrics to date. Overall, the relative performance standards are based on less than 4-year running averages for some metrics. The results provided cannot determine success in relation to the performance standards, but suggests the SELRP is on track at this time to meet the performance standards in the future.

The ecological objectives of the project are to enhance the existing physical and biological functions and services of San Elijo Lagoon. All relative metrics in this Annual Monitoring Report (Table 15-1) are equally important to the success of the project. Some relative metrics have multiple components that are evaluated for performance (i.e., density and species richness for fish and benthic invertebrates), and to ensure these metrics do not disproportionately impact the overall performance assessments, these components have been weighted 0.50 in the relative performance evaluation (Table 15-1). Each relative metric (e.g., fish, water quality, Spartina) therefore receives equal weight in determining project success.

Table 15-1. SELRP Year 1 Post-Construction Relative Performance Standards

Relative Variable	Site Similar to Other Wetlands			
	SELRP	Tijuana Estuary	Mugu Lagoon	Carpinteria Salt Marsh
Water Quality[1]	Yes	Yes	Yes	Yes
Fish Density[2]	Yes	Yes	Yes	Yes
Fish Species Richness[2]	Yes	No	Yes	Yes
Invertebrate Density[2]	No	Yes	Yes	Yes
Invertebrate Species Richness[2]	Yes	No	Yes	Yes
Spartina Canopy Architecture[1]	Yes	Yes	N/A[3]	N/A[3]
Number of Standards Similar to Other Wetlands[4]	3.5	3	3	3
Weighted Prop[4]. of Standards Similar to Other Wetlands	0.88	0.75	1.00	1.00

SELRP = San Elijo Lagoon Restoration Project; N/A = not applicable
[1] ***Based on 1 year of post-construction data (final performance standard requires 4-year running average)***
[2] ***Based on 2 years of post-construction data (final performance standard requires 4-year running average)***
[3] ***Spartina survey data not available.***
[4] ***Density and species richness are each weighted 0.50 within fish and benthic invertebrate metrics.***

Conclusion: The SELRP met more standards than Tijuana Estuary, the reference site with the lowest number of standards met. Although this result is based on less than 4-year running averages, it suggests SELRP is on track during Year 1 post-construction to meet the relative performance standards in the future.

Table 15-2. Timeline of SELRP Overall Project Success

Permitting Agency	Variable	Year Performance Standard Met											
		0	1	2	3	4	5	6	7	8	9	10	Final Standard Met[5]
CCC	Relative Performance Standards[1]	-	Yes[4]	-	-	-	-	-	-	-	-	-	-
	Project Design Absolute Performance Standards												
	Topography[3]	Yes	Yes	-	-	-	-	-	-	-	-	-	-
	Bathymetry[3]	Yes	Yes	-	-	-	-	-	-	-	-	-	-
	Tidal Elevations	-	Yes	-	-	-	-	-	-	-	-	-	-
	Exotic Cover	-	Yes	-	-	-	-	-	-	-	-	-	-
	Pre-Restoration Absolute Performance Standards												
	Breeding Marsh Birds: Light-Footed Ridgway's Rail Density	-	Yes	-	-	-	-	-	-	-	-	-	-
	Breeding Marsh Birds: Light-Footed Ridgway's Rail Abundance	-	Yes	-	-	-	-	-	-	-	-	-	-
	Western Snowy Plover	-	Yes	-	-	-	-	-	-	-	-	-	-
	California Least Tern	-	Yes	-	-	-	-	-	-	-	-	-	-
	Belding's Savannah Sparrow	-	No	-	-	-	-	-	-	-	-	-	-
USFWS/CCC	Habitat Areas	Yes	Yes	-	-	-	-	-	-	-	-	-	-
	Vegetation Cover[2]	-	Yes	-	-	-	-	-	-	-	-	-	-
RWQCB	Wetland Function (CRAM)	-	Yes	-	-	-	-	-	-	-	-	-	-
Corps	Eelgrass	-	Yes	-	-	-	-	-	-	-	-	-	Yes
Corps/USFWS	*Caulerpa*	-	Yes	-	-	-	-	-	-	-	-	-	Yes

Conclusions by Year:

Year 0. Topography, bathymetry, and habitat areas standards met. Data not available for all other variables. Monitoring will continue for all variables.

Year 1. Relative performance standards, topography, bathymetry, tidal elevations, habitat areas, vegetation cover, exotic cover, breeding marsh birds with focus on light-footed Ridgway's rail, western snowy plover, California least tern, wetland function (CRAM), eelgrass and *Caulerpa* standards met. Belding's savannah sparrow standard not met. Monitoring discontinued for eelgrass and *Caulerpa*. Monitoring will continue for all other variables.

CCC = California Coastal Commission; CRAM = California Rapid Assessment Method; RWQCB = Regional Water Quality Control Board; SELRP = San Elijo Lagoon Restoration Project; USFWS = U.S. Fish and Wildlife Service, - = data not available for that year.

[1] Not all required to be met in a given year.

[2] Interim standards are provided in Table 6-2 (see Chapter 6) for Years 1 through 9. Should the Year 10 standards be met prior to Year 10, monitoring may cease for this variable or may continue at a reduced frequency depending on the trajectory of other variables.

[3] It is assumed site conditions would not change frequently enough to necessitate annual surveys or negate previous survey results for topography and bathymetry. Success of both of these absolute standards is tied to habitat, which is being monitored every year. Topography and bathymetry metrics will be considered met in the years between monitoring topography and bathymetry if the habitat performance standard is met. Therefore, if the topography and bathymetry standard was met during monitoring in Year 2 and Year 5 and the habitat standard was also met in Year 2 through Year 5, topography and bathymetry standards would be considered met during Year 2 through Year 5.

[4] Some performance standards may be evaluated or in part based on running averages less than the required 4-year interval.

[5] Metric will no longer be monitored.

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16. ADAPTIVE MANAGEMENT RECOMMENDATIONS

16.1 RECOMMENDATIONS

Adaptive management as applied to ecological restoration is a systematic decision-making process in which the results of restoration activities are consistently monitored and evaluated to identify whether the restoration program is reaching its desired results. The process for adaptive management for each of the metrics being monitored in San Elijo Lagoon is ongoing with timelines and actions depending on the individual variable, as described in the Monitoring Plan. The monitoring protocol for each metric has been established to identify specific concerns associated with each variable early enough in the post-restoration phase to enable remedial measures to be taken if necessary and as feasible to achieve project success.

These annual reports evaluate and determine if the performance standards have been met and will continue to document monitoring results within the annual reports prepared at the end of each year. If performance standards have not been met for variables and monitoring trends indicate the specific function is not heading towards achieving success, adaptive management strategies will be identified and implemented. If necessary, Nature Collective will review the data with the relevant permitting and resource agencies, or with local experts, in an effort to devise a mutually agreed upon course of action to bring the particular variable into conformance with performance standards. Restoration was completed for the SELRRP in 2020, and this was the first complete year of post-construction data collection. The results discussed in this Annual Monitoring Report show the project is trending towards success and there are no recommendations at this point in time. While there are no recommendations at this time, there are two components of the monitoring being considered for revision after 2022 monitoring is conducted. These components are a reduction and/or discontinuation of vegetation cover monitoring and Spartina monitoring to reduce impacts to sensitive species present in the lagoon, as discussed in Sections 6.1.4 and 6.2.4.

16.2 ONGOING RESTORATION AND MAINTENANCE ACTIVITIES

Specified maintenance and monitoring will continue in Year 2 (2022) and through the remainder of the monitoring program. Ongoing activities include weeding and exotics removal, nest site and inlet maintenance, and predator control. Focused activities that may occur as adaptive strategies will be captured in the 2022 Annual Monitoring Report. Although nothing is specifically recommended based on the monitoring results in this 2021 Annual Monitoring Report, consistent monitoring continues in the lagoon. Therefore, additional focused activities may occur as the year progresses.

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17. LIST OF PREPARERS

Table 17-1 includes a list of persons and organizations who participated in the monitoring program and/or preparation of this Annual Monitoring Report.

Table 17-1. List of Preparers

Chapter	Variable	Lead Author	Organization
1–14	General Report Preparation	Cindy Kinkade (Project Manager)	AECOM
		Kandiss Wise	AECOM
2	Topography	Chris Webb	Moffatt & Nichol
3	Bathymetry	Chris Webb	Moffatt & Nichol
4	Tidal Elevation	Chris Webb	Moffatt & Nichol
5	Habitat Areas	Aaron Andrews	AECOM
6.1	Vegetative Cover	Aaron Andrews	AECOM
6.2	*Spartina* Canopy Architecture	Aaron Andrews	AECOM
6.3	Exotics	Aaron Andrews	AECOM
7	Water Quality	Nature Collective	Nature Collective
8	Benthic Invertebrates	Andres Deza	Nature Collective
9	Sediments	Nature Collective	Nature Collective
10	Fish	Andres Deza	Nature Collective
11.1	Breeding marsh birds with focus on light-footed Ridgway's rail	Michael Kuehn; Loren Merrill	AECOM
11.2	Western snowy plover, California least tern, and waterbird species	Michael Kuehn; Loren Merrill	AECOM
11.3	Belding's savannah sparrow	Michael Kuehn; Loren Merrill	AECOM
12	Wetland Function (CRAM)	Aaron Andrews	AECOM
13	Eelgrass	Nature Collective	Nature Collective
14	*Caulerpa*	Nature Collective	Nature Collective

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